P.4. 17E,

Toroids P.123

7 DEC 1976

NOVEMBER 25, 1976

CAN YOU TRUST YOUR HANDHELD CALCULATOR?/77

Pinpointing logic faults by current tracing/106

How to predict the cost of a semiconductor memory system/117

Toy

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International

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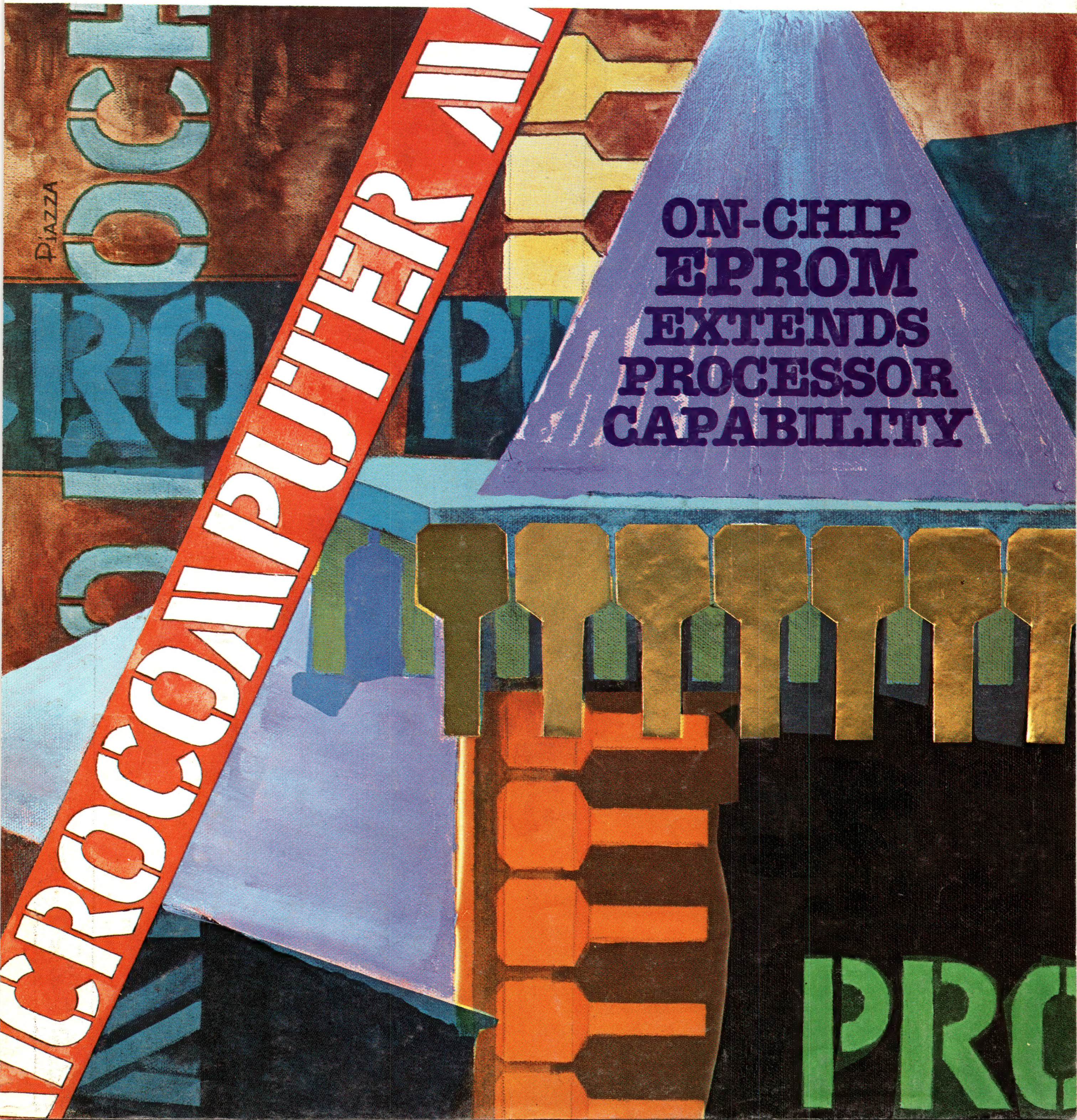

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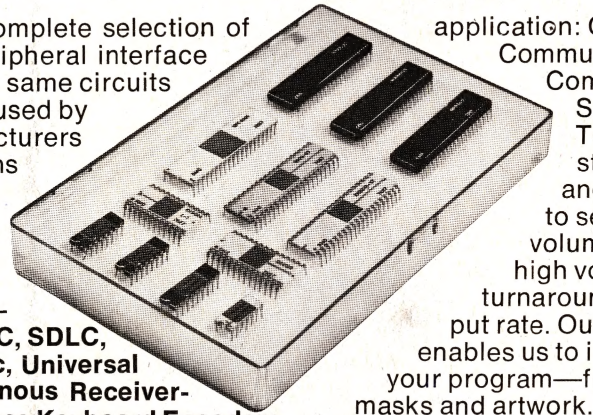

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Circle 1 on reader service card

Electronics

The International Magazine of Electronics Technology

Vol. 49, No. 24 • November 25, 1976

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Highlights

Cover: 8-bit microcomputer fits onto one chip, 99

An 8-bit microcomputer with erasable or nonerasable memory fits all elements needed for stand-alone computing onto a single chip. Through expansion with peripheral memory chips, it can also be used in many high-powered data-processing systems.

Theme of the cover illustration, by Assistant Art Director Paula Piazza, is the ultraviolet-erasable PROM of one version of the new Intel device.

Consumer electronics to boom in Spain, 89

Color-television sets will lead the expansion in Spain's consumer electronics next year, but other market sectors will show no real growth. This is the first in a series examining the electronics markets in various European countries.

Inductive pickup is key to fault tracing, 106

A handheld, self-contained probe traces current distributions by inductive pickup to determine exactly which integrated circuit has failed or, for an interconnection problem, the location of the short or open circuit. Since the probe responds only to current, it is compatible with all logic families

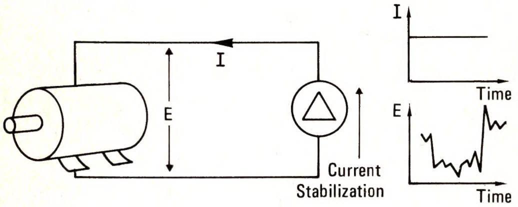
Semiconductor-memory costs loom larger, 117

Even though unit costs of semiconductor memories are dropping, their share of total system costs is rising as designers opt for more storage. Careful prediction of lifetime memory costs is essential—and possible with attention to a few parameters.

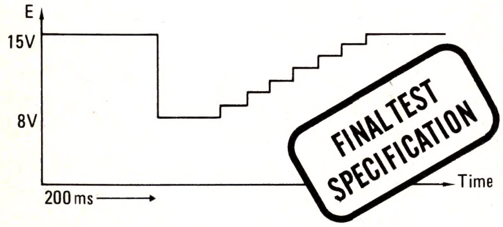
And in the next issue . . .

Converters meet microprocessors . . . an electrically alterable Famos ROM . . . microcomputer control comes to microwave ovens.

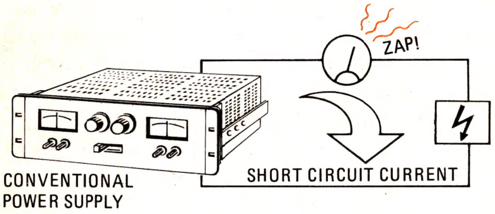
four important reasons to specify the KEPCO OPS power supply



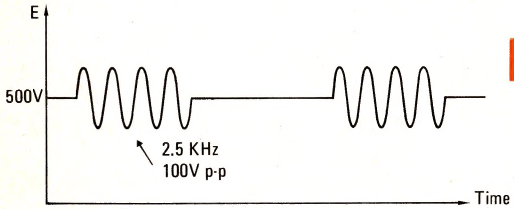
1 **YOU'VE GOT THIS MOTOR** that wants to be driven by constant current. Trouble is, its impedance varies wildly, and your conventionally-filtered current regulator can't hardly keep up. **YOU NEED A KEPCO OPS**—whose lack of output capacitance allows a stabilized current to be stable—even though the compliance voltage is doing nip-ups.



2 **YOUR SYSTEM DESIGNER SPECIFIED THIS TEST SEQUENCE:** *. . . "15V for 200 milliseconds, shift to 8V (1 ms settling time) then stair step back to 15V @ 20 ms/step in 1V steps."* Your conventionally-filtered power supply has a shunt capacitor that takes a half-second just to make it down to 8V . . . . **YOU NEED A KEPCO OPS,** whose capacitorless output circuit can be programmed rapidly (up to 1V/µsec) and yet suppress ripple and noise some 60–80 dB below peak output.



3 **YOU'VE POWERED UP THIS SENSITIVE LOAD** that suddenly shorts – zapping the delicate series ammeter . . . . But the specs on your conventional power supply said "current limited." Problem is, the output capacitor isn't included! **YOU NEED A KEPCO OPS:** No output capacitor, no surge current, even when shorted!



4 **YOU NEED TO SUPERIMPOSE THIS 2.5 KHz MODULATION** on top of a d-c level. You can either buy a modulator/amplifier and put it in series with your conventionally-filtered power supply, or **USE A KEPCO OPS,** which is a "modulatable power supply" and which for 1V/µsec slewing, will allow you up to 100V p-p modulation at 2.5 KHz.

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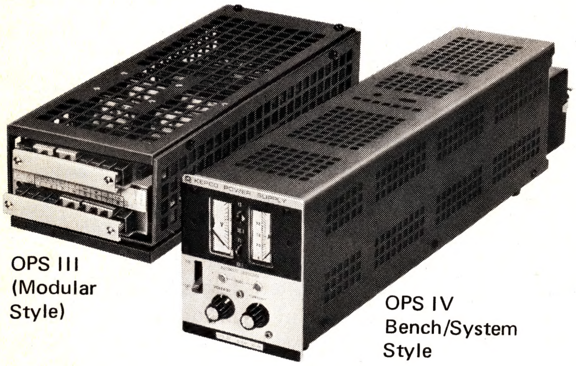

Of course, OPS are not for *every* application. Sometimes a big shunt filter is a good friend. Kepco makes a comparable line of capacitor-filtered models for these applications too. Our Catalog/Handbook contains extensive discussion about the dynamics of power supplies. Send for your copy today!

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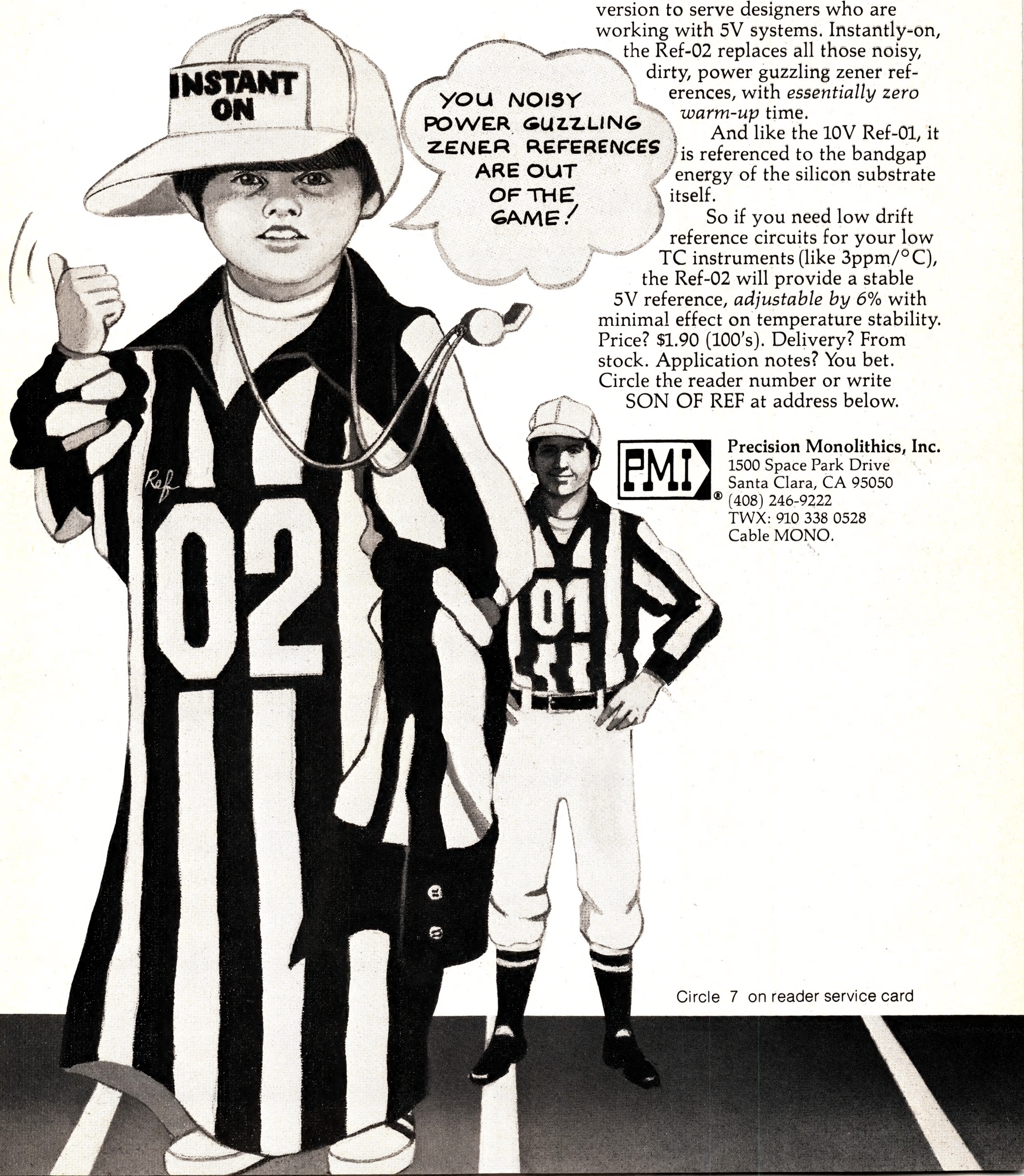
And like the 10V Ref-01, it is referenced to the bandgap energy of the silicon substrate itself.

So if you need low drift reference circuits for your low TC instruments (like 3ppm/°C), the Ref-02 will provide a stable 5V reference, *adjustable by 6%* with minimal effect on temperature stability. Price? $1.90 (100’s). Delivery? From stock. Application notes? You bet. Circle the reader number or write SON OF REF at address below.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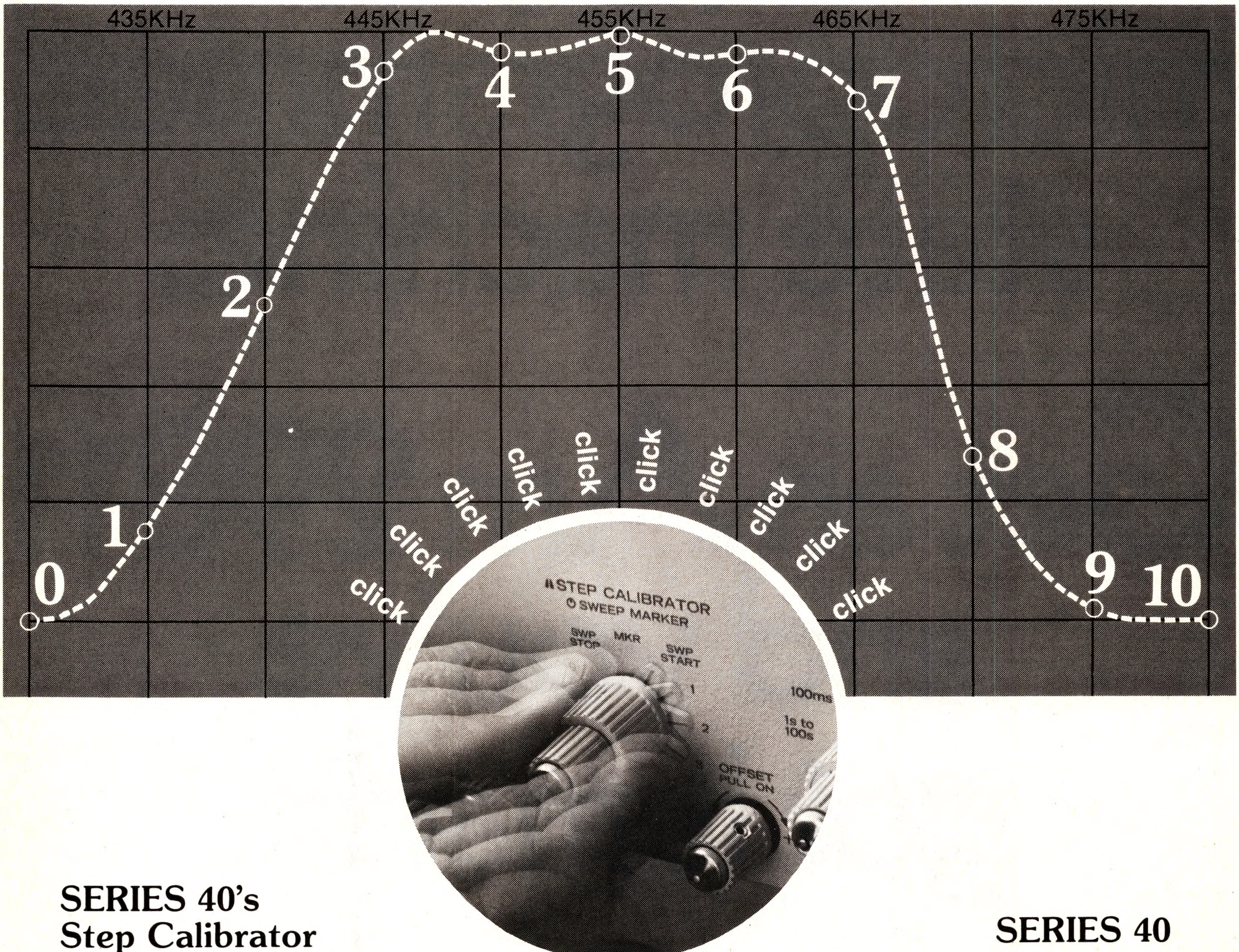
How to get through a bandwidth in ten easy steps.



SERIES 40's Step Calibrator measures frequency response with the click of a switch.

Set SERIES 40's main dial *once,* and you'll get eleven precise frequencies in ten equal steps by simply clicking the Step Calibrator switch from zero to ten. With 1000:1 frequency change in the log mode, each step is equivalent to approximately one octave, which is particularly useful in audio testing. And unlike other function generators, SERIES 40 allows you to step up or down without having to cycle through the entire ten steps.

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SERIES 40 gives you plenty of amplitude — 40 V peak-to-peak (open circuit) — and takes the guesswork out of pinpointing response with its continuously variable Frequency Marker. SERIES 40 also offers you INTERSTATE's exclusive direct-reading sweep limit control and full spectrum of function generator capabilities in five models from $475 to $695. For additional SERIES 40 specifications, call Product Marketing at (714) 549-8282, or write Interstate Electronics, Dept. 7000, Box 3117, Anaheim, CA 92803.

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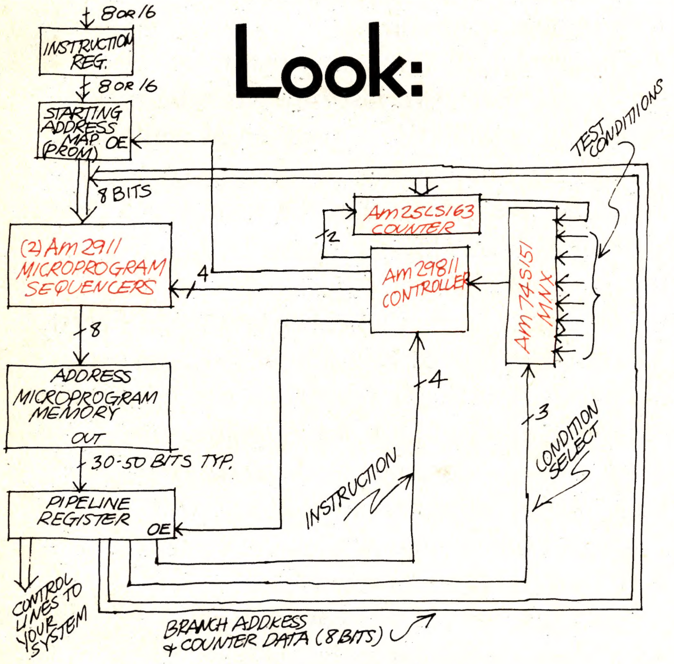
If you make state machines—and you're tired of gates and flops and hassles and headaches—we've just made your life a lot easier.

Get an Am29811, add some Am2911's and you get an amazingly powerful, efficient microprogram controller. Throw in a couple other 16- and 20-pin packages, and throw away your state machine problems. For good.

Look:



The Am2911 provides logic for sequential addressing, branching to any address, four levels of subroutining and looping.

The Am29811 is used to control the Am2911, as well as a loop counter and several branch address sources. The resulting system executes sixteen sequence control functions, most of which can be conditional. (With a 60ns microprogram memory, a typical system can run at 5MHz clock rate—even faster with some minor logic modifications. Wow!)

Two Am2911's can control up to 256 words of microprogram, enough for many state machines. (With three Am2911's, up to 4K words of microcode can be controlled.)

Look again:

Sequence Control Instructions

Jump to Zero
*Jump to Branch Address
Load Counter
*Repeat Jump if Counter ≠ 0
*Push PC or Push PC and Load Counter
Jump to Map Address
*Loop
*Repeat Loop if Counter ≠ 0
*Jump to Subroutine
*Return
*Jump to One-of-Two Subroutines
*Jump and Pop Stack
Jump to External Address
Jump to Branch Address
*Jump to One-of-Two Branch Addresses
Continue

*Conditional Instructions

Terrific. But how much? Am2911, $2.95 in volume. Am29811, $2.60 in volume. The entire controller shown, including 8-bits of loop counter and 8-input multiplexer is only $11.64. That's right. $11.64 total price.

If you want to know more about the Am2911 or the Am29811, just wire, write or phone. We'll send you a whole book about microprogrammed controllers. For free, of course.

Boy. Some guys really have it made.

Advanced Microprocessors

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MOS: from Europe with authority

MOS technology, as everyone knows, is originally American. But here in Europe we at SGS-ATES have right from the beginning given it an industrial application which has helped us to achieve and maintain leadership in this field.

Let's highlight the main steps in a decade of progress.

1966 - setting-up of the MOS department
1968 - the first MOS calculator designed in Europe (10 chips)
1969 - technological innovation with the Planox® process
1971 - design of a multichip calculator system organised like the microprocessors we know today
1972 - a 2-chip calculator with printout
1973 - the first rhythm generator for electronic organs
1974 - the M38 8-bit microprocessor, a 4k ROM and a 1k RAM
1975 - new LSI circuits for musical instruments and a 30 channel remote control system for TV (MI024, MI025), the first results of a large undertaking by the company in this sector.

That is the history to date of our achievements in the MOS field. That is, in fact, the history of MOS in Europe.

And now a 4k RAM

The M340, a 1 x 4096-bit dynamic random access memory, as fast as any in the world: 200 ns max access time, 400 ns max cycle time.

It is produced with N-channel high-voltage technology and mounted in a 22-pin package.

Soon to be offered in a 16-pin version (M341).

And that's why

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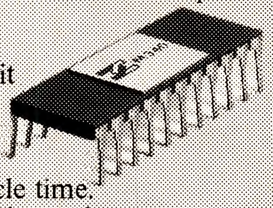

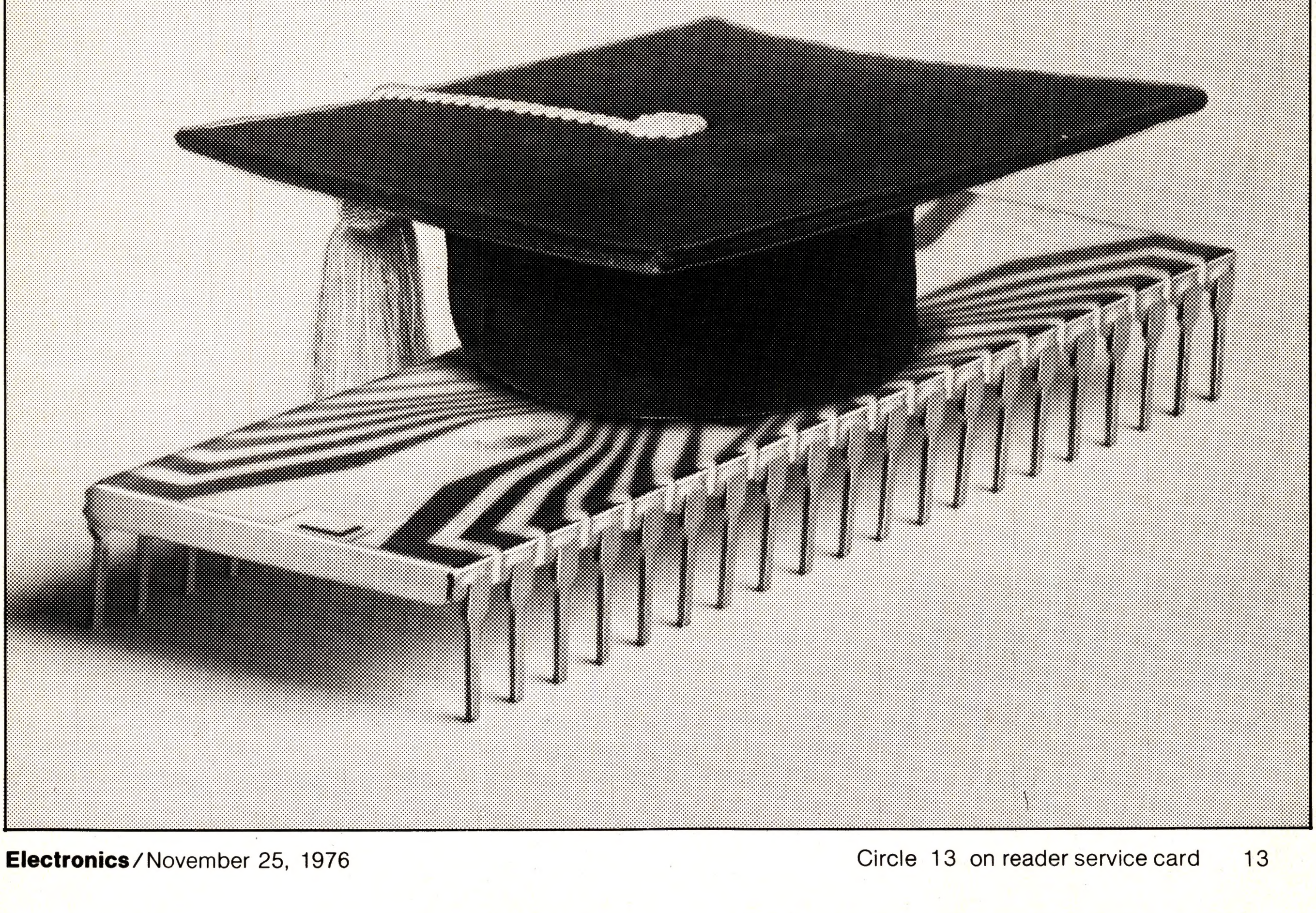

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Circle 234 on reader service card

hp MEASUREMENT COMPUTATION news

product advances from Hewlett-Packard

INTERNATIONAL edition

NOVEMBER 1976

in this issue

Full ASCII code in new matrix LED display

Recorders and CRT displays for the OEM

14.9 Mbytes of memory for HP 9825A

A new data acquisition system can measure parameters in the form of ac, dc and resistance, analyze the information and make decisions, process the information, present results in graphic or printed format, interact with a process and provide alarm and switching functions.

NEW data acquisition system reads up to 19 channels/sec with 1 μV resolution

With capabilities found in many larger computer-based systems, the HP 3052A Automatic Data Acquisition system is a lower cost alternative for fast process monitoring and control, component and product test, environmental and energy use monitoring, stimulus/response testing and signal analysis.

Under control of the HP 9825A desktop computing controller, the HP 3052A uses two digital voltmeters to cover its wide measurement range and speed—the HP 3455A, a high resolution, high accuracy digital voltmeter and the HP 3437A, a high speed dc systems voltmeter. Inputs to both DVM's may be switched by the HP 3495A scanner. The 9825A takes over system control interfacing and data processing.

Dc measurements up to 19 channels/sec are possible with 1 μV resolution on the 100 mV range.

Excellent noise rejection and low thermal uncertainty make the 3052A suited for accurate, repeatable, low-level measurements even in the presence of noise. The >120 dB effective common-mode rejection of the 3455A/3495A effectively cancels out unwanted offsets or super-imposed signals.

Consider the wide range of problem solutions offered in the 3052A System:
- Signal digitizing
- High-speed scanning
- System timing
- Two-level interrupt system
- High-speed data access and storage
- Alphanumeric display for easy interaction with the operator.

For more information on data collection, processing and control solutions, check D on the HP Reply Card.

Memory of 9825A desktop system can be expanded in multiples of 468,480 bytes

HP-IB

With its live keyboard, vectored priority interrupt, direct memory access, and built-in tape storage, the 9825A can control and acquire data from several instruments while it performs calculations, prints or plots results, and reviews programs—all through simple keyboard commands and with apparent simultaneity.

Two fast, low-cost flexible disk drives expand the usefulness of the HP 9825A programmable desktop computing system.

The new disk drives, the 9885M (master) and 9885S (slave), have a memory capacity of up to 468,480 bytes per disk.

The master, in addition to containing the built-in power supply, contains the controller for managing the operations of the slave units. Up to eight 9885M master drives can be connected to a 9825A, and up to three slave drives can be connected to each master—a total of 32 separate disks with 14,991,360 bytes of user available memory. The flexible disks provide virtually unlimited economical off-line storage for both programs and data.

Fast transfer rates are achieved through the direct memory access (DMA) feature. Instantaneous transfer rate of information between the disk drive and the calculator is 62,500 bytes/sec; continuous throughput rate is 23,000 bytes/sec. Average access time to any place on the disk is 260 msec.

Double density read/write on the disk enhances the access rate in addition to increasing the total storage capacity. The 9885M is controlled by a high-level command system that organizes the data into named files on the disk. A directory keeps track of the names of the files, where they are located, and the size and type of the files.

Write-verify automatically ensures that the information recorded on the disk is identical to the source information in the memory. Additional features include the ability to sort and print the directory or catalog information, recover data after a check sum error, and copy files, portions of files, or complete disks to other disks. Data can be organized serially or randomly for optimum data access.

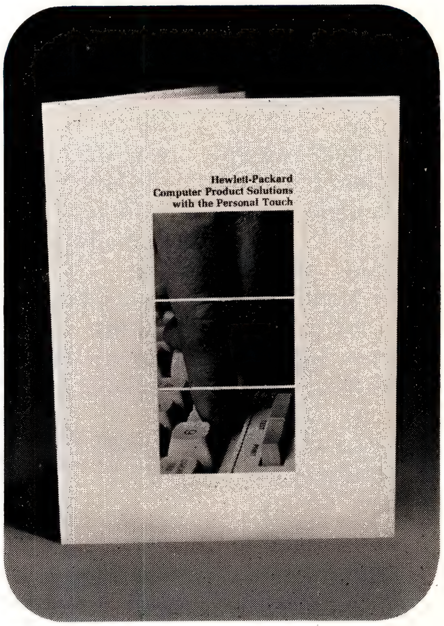
The new 9878A Expander increases the usable I/O channels from three to nine. The addition of two expanders to the 9825A, in combination with the HP Interface Bus, makes it possible for the 9825A to interface with as many as 210 instruments and/or peripherals.

For more information on this computing and controlling capability, check K on the HP Reply Card.

HP-IB

The HP Interface Bus (HP-IB) is Hewlett-Packard's implementation of IEEE Standard 488-1975 and identical ANSI Standard MC1.1, "Digital interface for programmable instrumentation."

Presenting...computer product solutions from HP



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Computer Product Solutions
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Illustrated are examples of how such diverse organizations as Eastman Kodak, General Motors, The Travelers Insurance, Yale University, Walter Reed Hospital and Bell Labs are using our computer products.

Check Q on the HP Reply Card.

A wide range of DC power supplies are now HP-IB programmable

59501A HP-IB ISOLATED D/A / POWER SUPPLY PROGRAMMER
HEWLETT·PACKARD
ZERO ADJUST
D/A FULL SCALE ADJUST
POWER SUPPLY FULL SCALE ADJUST
COARSE
FINE
LISTENING
ON
HP-IB

Utilizing the new 59501A programmer, you now may select from more than 80 HP power supply models for use in HP-IB test systems.

A new isolated D/A converter / power supply programmer, the HP 59501A, provides a convenient interface between the Hewlett-Packard Interface Bus and over 80 models of HP power supplies. Output voltage (or current) control of remotely programmable power supplies is accomplished by voltage programming from the 59501A, with gain provided by the power supply control circuits.

Isolation is rated at 600 Vdc between the input HP-IB data lines and output terminals to keep all power supply circuits separated from the controller and bus-connected instruments.

Output from the programmer is from 0 to 9.99 volts in 10 mV steps. Accuracy is 0.1% plus 5 mV. Increased resolution and accuracy are available over the lower 10% of output using the HP-IB programmable 0.1 X range. A network in the 59501A programmer may be adjusted to match the various power supply programming coefficients and full scale output ratings. In addition, the programmer output may be manually switched to a bipolar mode required for controlling power supply/amplifiers.

The 59501A may also be used as a low level DC voltage source with a conversion time of <150 μs and output current up to 10 mA.

For additional details, check H on the HP Reply Card.

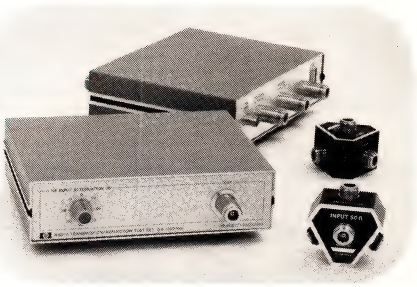
New RF test sets offer convenience and precision

Two precision RF test sets, designed for use with the HP 8505A Network Analyzer (500 kHz to 1.3 GHz), are available separately so they can be used with such other RF instrumentation as the popular HP 8405A vector voltmeter (1-1000 MHz), HP 8407A 110 MHz network analyzer system, and HP 8755 frequency response test set (two-channel, magnitude-only detection and display system).

Model 8502 transmission reflection test set contains both a precision power splitter and a high directivity directional bridge permitting simultaneous measurement of transmission and reflection coefficients of the device under test. Also included in the test signal channel is an RF attenuator with 70 dB range in 10 dB steps, which means sensitive devices can be tested at very low test signal levels. The test device can be biased through a dc bias network incorporated within the set. This test set is available with test port impedance of either 50 ohms (8502A) or 75 ohms (8502B). The 75 ohm version is configured to allow measurements in 75 ohm systems using 50-ohm instrumentation.

The HP 11850 three-way power splitter is an extremely flat, well-matched signal divider useful for such transmission measurements as gain or loss, matched pair gain or loss, and comparison tests. The three output ports can be either 50 ohms (11850A) or 75 ohms (11850B).

For more details, check J on the HP Reply Card.



Precision test sets for measuring 50 and 75 ohm networks in the 500 kHz to 1.3 GHz frequency range: (left) HP 8502A/B transmission/reflection tests sets with built-in 70 dB attenuator, and (right) HP 11850 A/B three-way power splitters.

New application note for testing active RF devices

Measuring the gain characteristics of active microwave devices—primarily amplifiers and transistors—has traditionally been a time consuming procedure because many tests had to be performed at discrete (i.e., CW) frequencies. Now a new HP Application Note (AN 155-1) describes how to make *swept-frequency* measurements of such important parameters as:

1. Gain and Power Output
2. Gain Compression
3. Harmonic Content

(CW Gain vs. Power *Output* is also described; a more convenient test than the traditional Gain vs. Power *Input*).

These applications are keyed to the HP 8755 Frequency Response Test Set, a versatile dual-channel detection and display system with ratio-ing capability and 60 dB dynamic range. Frequency coverage of the 8755 is from 15 MHz to 18 GHz. Operating instructions and accuracy considerations are included in this eight-page note.

Send for your copy today. Check O on the HP Reply Card.

OEM
NEWS

At Hewlett-Packard, your OEM dollar buys more than just hardware

When you purchase OEM equipment from Hewlett-Packard, you are assured of product performance, service and applications assistance from a company that recognizes your reputation and success depend partly on the support you receive from your OEM supplier.

Confidence can be yours with the knowledge that HP is ready to respond to your needs with over 3,000 sales, service and technical personnel located in 172 offices in 65 countries.

A highly competitive OEM discount structure is offered across a wide selection of instruments. In addition, many instruments can be custom tailored to meet your specific needs.

Confidence is yours when an HP recorder is part of your OEM system

HP instrumentation tape recorders, including the eight-channel shown above, are designed and packaged for versatility, portability and durability.

With the addition to the OEM recorder line of eight and four-channel instrumentation tape recorders, the HP 3968A and 3964A respectively, high performance data collection is realizable for the systems you manufacture.

Both recorders use economical ¼-inch tape. A combination of FM and direct electronics permits recording from DC to 64 kHz. These compact, rugged recorders provide laboratory quality performance even in tough field environments. Standard features include TTL remote control, a push button built-in calibration source, tape servo, flutter compensation and voice annotation. Six tape speeds from 15/32 ips to 15 ips give you a 32:1 tape base compression or expansion for flexibility and easy data analysis.

Designed to serve the broadest possible range of OEM applications, HP also offers an extensive line of analog and graphic recorders including:

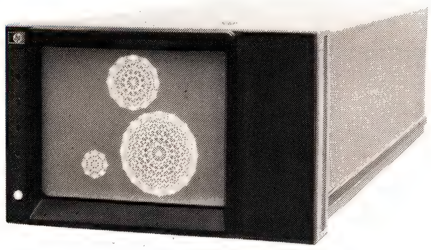
- **X-Y** Available in two basic configurations: 11×17″ (DIN A3) and 8½×11″ (DIN A4).
- **Strip Chart** Choose from four categories: single span, compact desk-top unit, "slim line" models, and a battery powered portable.
- **Graphic Plotters** Paper up to 11×17″ (DIN A3) can be used in three models for use with communications terminals and computers.

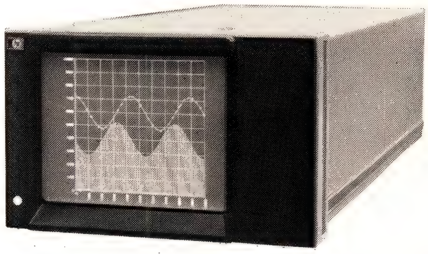
An OEM catalog describing all these models is available. For your copy, check F on the HP Reply Card.

An HP display will enhance your system's image

End users of your system will judge capability by the information displayed. HP's CRT Displays are excellent choices for many applications.

The 1332A, 1333A and 1335A displays all have a very small spot size that focuses uniformly over the complete viewing area, regardless of writing speeds or intensity level. Fine image detail with excellent contrast and uniformity make them particularly well suited for applications involving complex graphics, especially when combined with alphanumeric data.





If you need a larger viewing area, and a brighter image at fast scan rates, consider the **1332A** with a 9.6×11.9 cm viewing area.

For photographic recording of displayed data over the 8×10 cm area, the **1333A** offers an extremely small spot size (.20 mm).

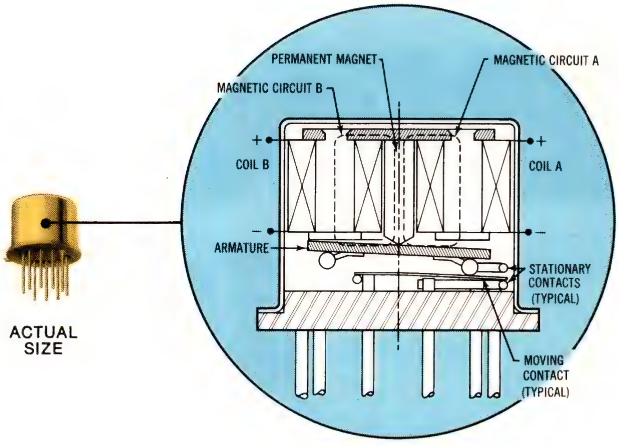
The **1335A**, a variable-persistence, storage and non-storage display has a totally new CRT design. For maximum flexibility, any operating mode—erase, store, write, conventional or variable persistence—can be selected with manual front panel controls, remote program inputs, or both.

HP also offers five large screen graphic displays for OEM computer graphic and instrumentation applications. These large displays have linear writing speed of 25.5 cm/μs and X/Y settling times of $\leq$500 ns.

For details on large displays, check B on the HP Reply Card. For smaller displays, check C on the HP Reply Card.

TO-5 RELAY UPDATE

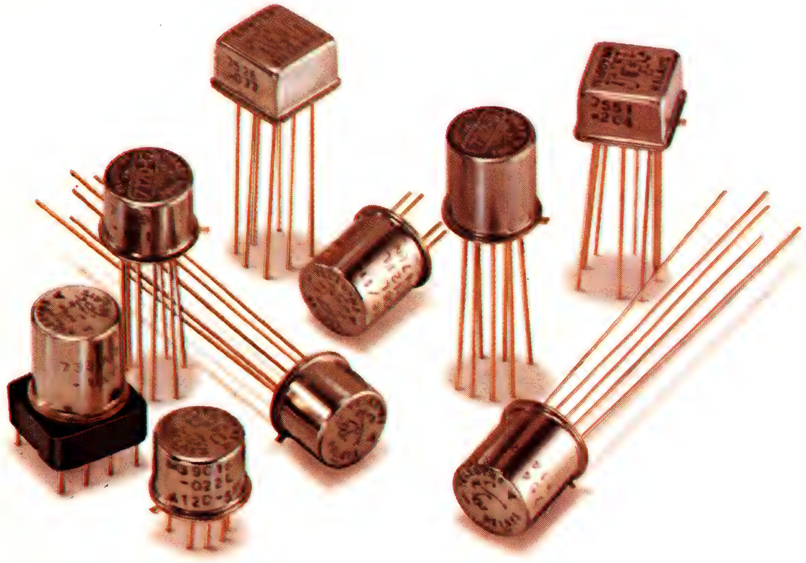
Maglatch TO-5: the relay with a mind of its own.



Whenever critical switching circuits call for non-destructible memory, choose Teledyne's magnetic latching TO-5 — the relay that remembers. Once set with a short pulse of coil voltage, it will retain its state until reset or reprogrammed — even if system power fails or is shut off. And you get the added advantage of reduced system power demands, since conventional relay holding power is not required.

But memory capability and low power consumption are not the only advantages of our TO-5 maglatch relays. Their subminiature size makes them ideal for high density pc board packaging, and they're available in SPDT, DPDT and 4PST contact forms. And for RF switching, their low intercontact capacitance and contact circuit losses provide high isolation and low insertion loss up through UHF.

Our magnetic latching as well as our complete line of TO-5 relays includes military and commercial/industrial types with MIL versions qualified to "L" and "M" levels of established reliability specs. For complete data, contact Teledyne Relays — the people who originated the TO-5 relay.



OTHER TELEDYNE TO-5 RELAYS

- **Hybrid "T" Series**
  SPDT & DPDT types with internal transistor driver and suppression diode. Military and commercial/industrial versions.
- **"D" and "DD" Series**
  With internal suppression and steering diodes. Military and commercial/industrial versions.
- **Centigrid® Series**
  World's smallest relay—only .225″ (5.72mm) high x .370″ (9.40mm) square. DPDT, with optional internal suppression and steering diodes.
- **Hi-Rel Series**
  Screened versions for space flight applications (NASA qualified).
- **High Environment Series**
  Hi-temperature, Hi-shock, and Hi-vibration types.

TELEDYNE RELAYS

3155 West El Segundo Boulevard, Hawthorne, California 90250
Telephone (213) 973-4545

Circle 27 on reader service card

First, the Big Picture
The Mind Reader takes a first macro-bite out of the territory you're investigating. 256 big words. In Memory Mode you can see the areas of memory where the action occurred. (You're writing into ROM, for heaven's sake!?!)

Then zoom in!
The 168-D gives you a movable cursor that locks onto a location and stays with it through the analysis modes. Once you spot the action you've been looking for, stake it out with the cursor and switch to Page Mode. That gives you the address, data, and read/write information.

Now: A whole new perspective . . .
You've found the program, now switch to Sequential Mode and find out **how it got there.** Where were you coming from, and where did you go from there? Study all time relationships. A powerful new way to analyze the problem!

By switching to the List Mode you display the twenty words surrounding the cursor location you selected in the Page Mode. Address and data are presented in hex along with the R/W bit to let you compare the sequence to your program listing.

In summary: The 168-D lets you record with respect to time and analyze with respect to location.

It's the first microprocessor analyzer that really analyzes. You can put it to work today on **8080A** and **6800** problems. Personality modules for other µP's are currently under development.

So if you're working with microprocessors and want to know whether your software or hardware is giving you problems, Biomation's 168-D Mind Reader will tell all: What happened . . . where . . . and when. You've got to get the data sheet. Circle the number below. Better yet, call Biomation for a demo.

Biomation, 10411 Bubb Road,
Cupertino, CA 95014,
(408) 255-9500.
TWX: 910-338-0226.

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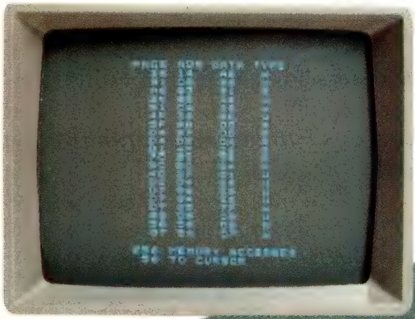
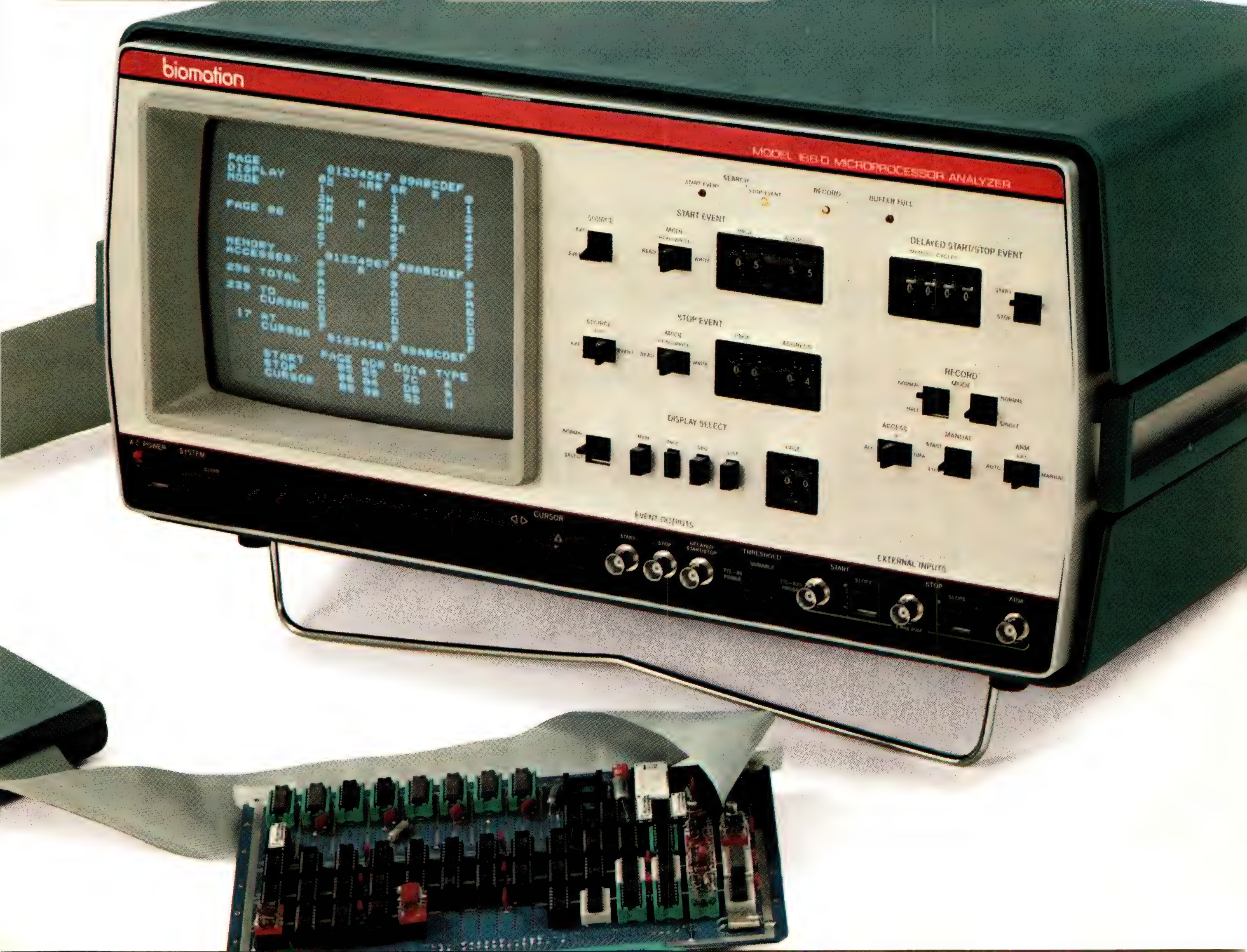
Creating tools for technology





Meet the Maestro...

...by any definition, the master in the art of digital voltmeter technology

Quite simply, the Maestro is the finest voltmeter in the world. A masterpiece in measurement technology.

It's the product that gives you more than any other on the market. Like unique Decastat display; seven 9's scale plus over-range; one ppm linearity; 200 readings/s and fast auto-range.

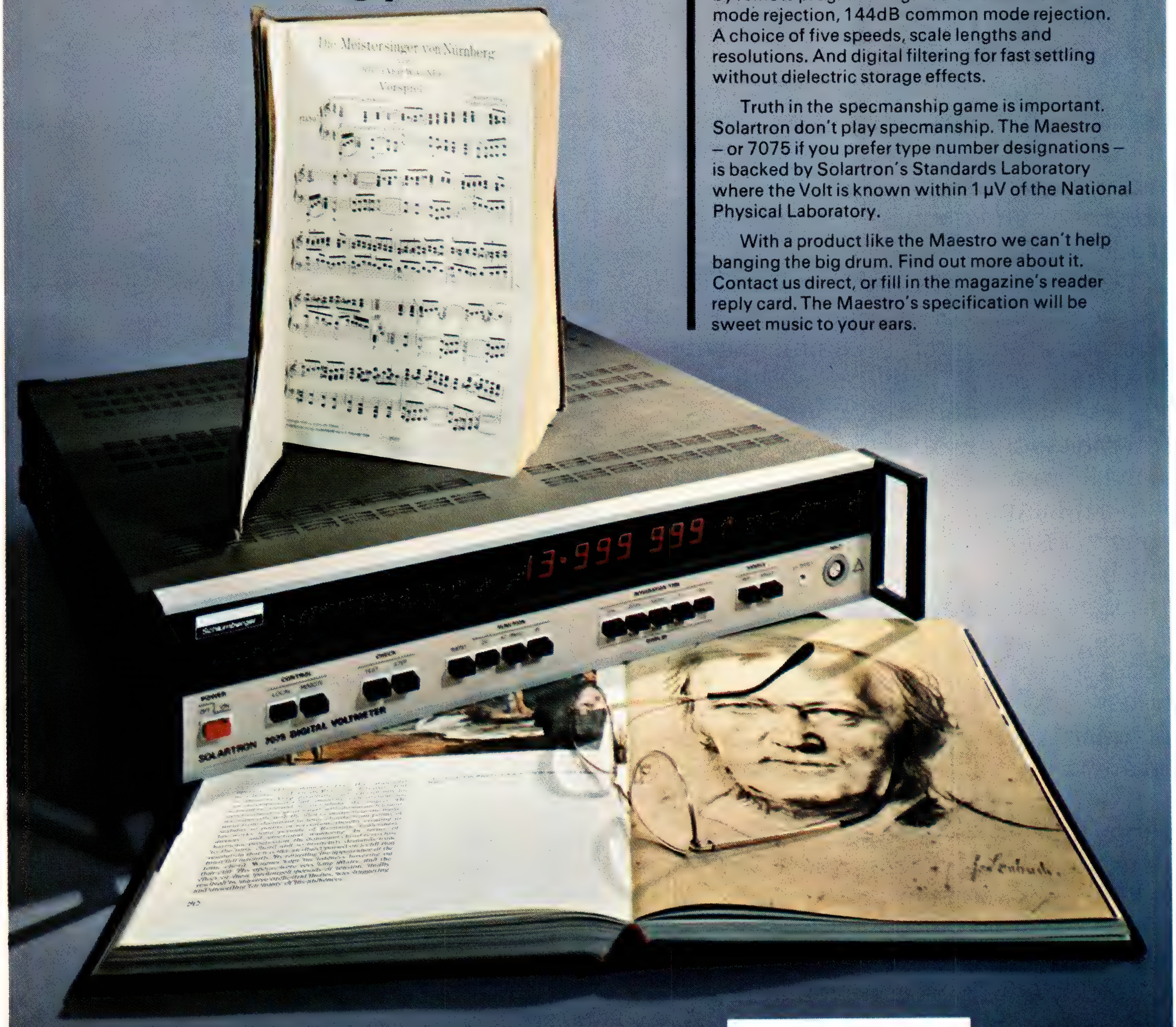
The new Maestro gives one in 14 million resolution. It knows the answer to 1 nV, it gives a result to 10nV in systems, and the display is rounded to 1 µV

- ■ dc voltage 1 µV to 1 kV
- ■ true rms ac voltage 1 µV to 750V
- ■ resistance 1 mΩ to 14MΩ

The Maestro cannot lie – not with a built-in self-check facility. And all its features are controlled by remote programming. Features like 70dB series mode rejection, 144dB common mode rejection. A choice of five speeds, scale lengths and resolutions. And digital filtering for fast settling without dielectric storage effects.

Truth in the specmanship game is important. Solartron don't play specmanship. The Maestro – or 7075 if you prefer type number designations – is backed by Solartron's Standards Laboratory where the Volt is known within 1 µV of the National Physical Laboratory.

With a product like the Maestro we can't help banging the big drum. Find out more about it. Contact us direct, or fill in the magazine's reader reply card. The Maestro's specification will be sweet music to your ears.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Farnborough, Hants. England.

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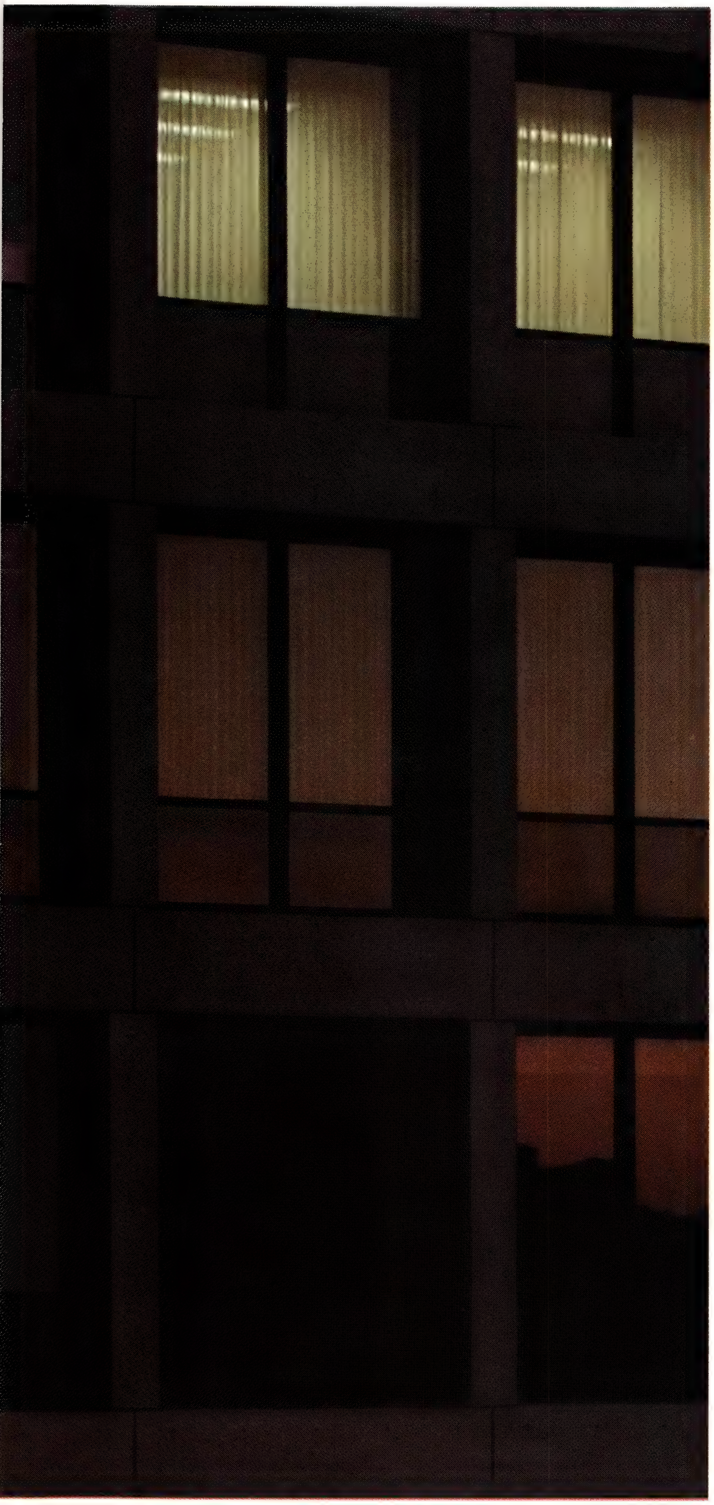
Circle 235 on reader service card

support takes of bit slice design.



the microprogram. ROM-SIM lets you examine or modify the program without blowing PROMs. Once the microprogram is debugged, you can program PROMs—transferring the microprogram stored in ROM-SIM to your PROM using the Intel Universal PROM Programmer.

Intel support doesn't end with CROMIS or the Intellec Microcomputer Development System. There's more. Field applications engineers are available to answer questions and give suggestions. Series 3000 application notes will give you helpful ideas on simplifying bit slice designs. And we offer customer workshops where you can get "hands on experience."

Whatever your bit slice application, you'll find the total support you get with the Intel Series 3000 cuts months off development time. Intel support makes the big difference. We take the overtime out of bit slice design.

For additional information use the reader service card. For quick response telephone: Belgium, (02) 660 30 10; Denmark, (01) 18 20 00; England, (0865) 77 14 31; France, (01) 687 22 21; Germany, (089) 55 81 41; Japan (03) 426-9261; Sweden, (08) 37 53 70.

intel®

Microcomputers, first from the beginning.

Electronics newsletter

Motorola decides not to supply F-8 microprocessor . . .

Motorola will make a two-chip version of its own 6800 microprocessor and not supply the F-8 microprocessor as part of its recent technology and product exchange with Fairchild Semiconductor. Reports that Motorola would build the device were widely circulated recently. John Welty, vice president and general manager of the Motorola Semiconductor Products division, said at the company's annual security analysts' meeting that the company will not manufacture the two-chip part; instead, **it will introduce in the second quarter of 1977 the MC6801 two-chip version of its own 6800 family** aimed at the same low-end market as the F-8.

Welty indicates, however, that his mind is still open on the newer single-chip F-8 soon to be produced by Fairchild and Mostek Corp. "We'll do it if we see a need in the market," he says.

. . . and gets back into watch module business

Motorola's Inc.'s on-again, off-again flirtation with liquid-crystal-display watch modules—which last went off again in October 1974—has turned on again. This time, the firm's Communications division in suburban Chicago will produce LCD modules **"for major watch companies, but not for a Motorola brand-name watch,"** the company has revealed. Samples are circulating, and volume production will start the first quarter of next year. According to Motorola, LCD watches priced at arount $20 by its customers could be on the market early next year.

At present, the company makes all the watch components—complementary-MOS chip, display, and quartz crystal—except the batteries. However, Motorola expects to start production of its own batteries soon. The modules are said to be about half of the width of present LCD types, and the display is back-lit for visibility in darkness.

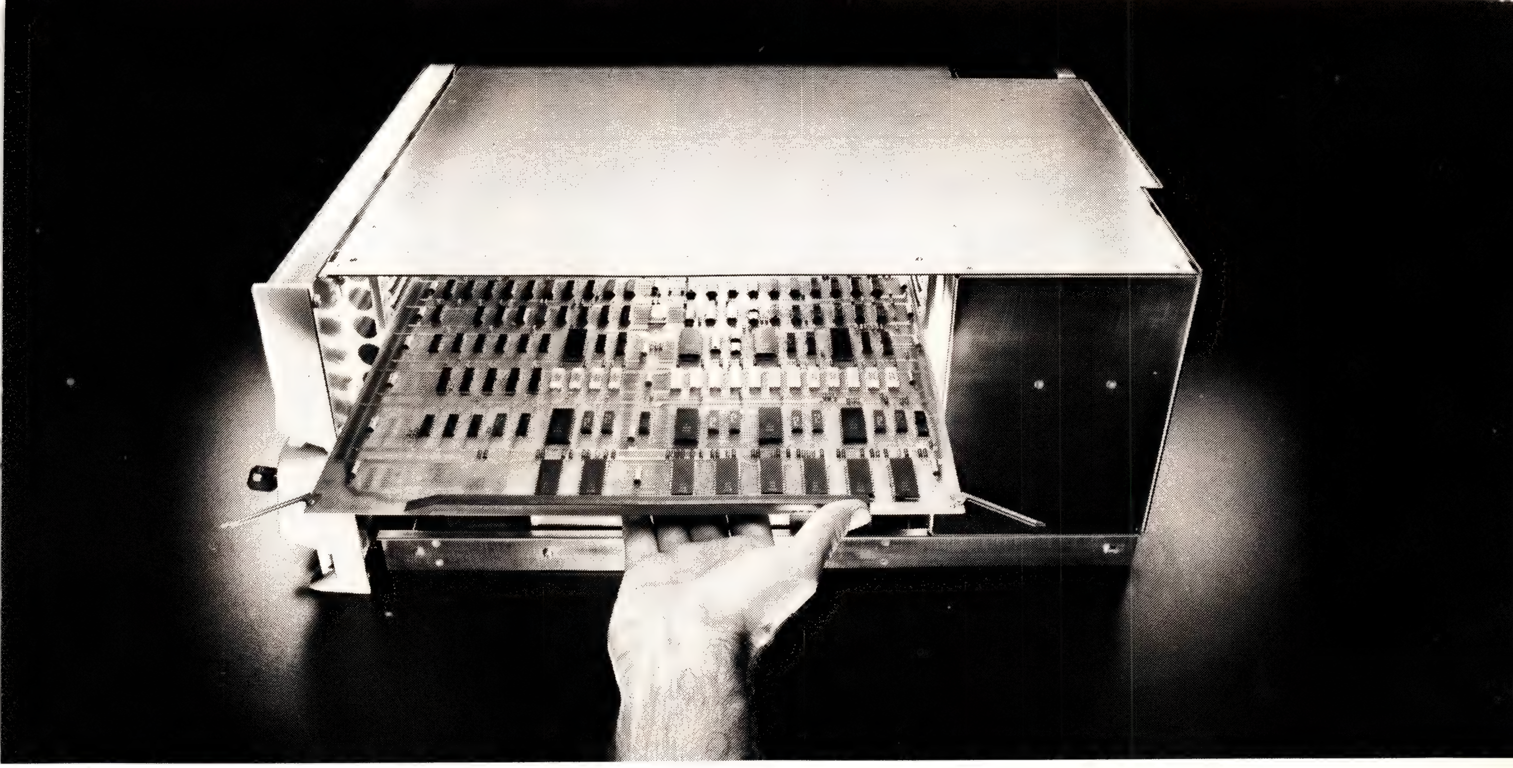
Research firm sees HP quitting low end of calculator market

Will Hewlett-Packard abandon the market for low-end scientific calculators? "No," says HP, but at least one institutional research firm, Paine, Webber, Jackson & Curtis Inc. in New York, predicts that HP's profit-pinched Advanced Products division **will elect to get out of that consumer-oriented sector.**

"Such a decision is inevitable," says Kent A. Logan, a Paine, Webber research vice president. "It should become increasingly obvious to international management that there is no way HP can compete with Texas Instruments on a cost, and therefore on a price, basis." HP's difficulties, adds Logan, stem from its lack of fully vertical integration and its production of a lower volume than TI. These factors probably result in higher per-unit overhead and marketing costs.

Proposals due for unit-level phone switch

Proposals for the U.S. military's next major tactical telephone-switching system, the unit-level switch, are due to be submitted to the Marine Corps in early January. The Marine Corps branch in the Naval Electronics Systems Command is handling the procurement, and the award for full-scale engineering development is probably worth $20 million to $30 million. The long-term production potential, however, **could be as much as $200 million** to equip units of division size and smaller in the field. Bidders in the competition are expected to include GTE Sylvania Inc., International Telephone & Telegraph Corp., Martin Marietta Corp., North Electric Co., and RCA Corp.



Give your data communications system a little goose and it'll put out ten times as much.

Open up the back of any Data General communications system, pop in our single-board DCU/50 Data Control Unit, run through a little step called COMGEN and stand back. Because that system can start pumping out ten times as much data. And possibly a good deal more.

What makes this all possible is a rather clever piece of engineering.

We've designed the DCU/50 as an intelligent programmable controller. So it takes over jobs the CPU used to do. Things like character handling and code conversion. Which frees up the CPU processing power and speeds up total systems throughput.

On the other hand, you may not need more throughput. Instead, you may need more lines or different types of lines. Both of which are just as easy to get. You just plug in some different boards.

We make modular synchronous and asynchronous multiplexors you can mix in any proportion. They can handle anything from one to sixteen lines, are fully software supported and work equally well with or without the DCU/50.

Which brings up a rather significant point.

When you buy your communications equipment from Data General, you can get exactly what you need right now. And later, if you need more throughput, more lines or different types of lines, you won't have to throw out anything. All Data General communications hardware and software are completely compatible. So you can add on to what you already have.

Write for our free brochure, "The Sensible Way to Use Computers in Data Communications" and detailed information about the DCU/50 Data Control Unit.

And if that isn't enough information, we'll send a sales engineer who can also put out ten times as much.

DataGeneral

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Circle 37 on reader service card

Moving right along, we drop the printer interface, and give you the above, plus:

☐ Protected formats.
☐ Block transmission to cut down on CPU functions and considerably reduce software needs.
☐ Selective transmission of only variable data.
☐ Upper and lower case ASCII display.
☐ Shift and lock keys.
☐ Transmission by page, partial page, line or character.
☐ Look-ahead cursor positioning to suppress trailing blanks.
☐ Automatic tabbing between fields.
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☐ Remote recognition of cursor position.

It's the Consul 920.
With its sophistication and flexibility, the 920 is a network designer's dream. Without a nightmare price. Single unit price, $2200.

Still with us? Then you need the works:

☐ Graphics that show everything from bar charts to diagrams.
☐ Alphanumeric annotation of graphics.
☐ Line insert or delete; remote or local.
☐ Character insert or delete.
☐ Overwriting.
☐ Parallel and serial peripheral interfaces.
☐ Remote or local printing.

It's the Consul 980.
Top of the line, and acts like it. You simply can't buy better. Single unit price, $2800.

Now. If you've said when, we'll say where:
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ADDS

IBM throws hat in minicomputer ring with Series/1

New system goes after knowledgeable end user who needs a minimum of applications-software support

IBM Corp. has put itself squarely in the minicomputer marketplace by producing low-end hardware and selling it, in a sharp departure from form, with a minimum of applications software. For less than $10,000, IBM will provide, with its new Series/1, a processor, input/output circuits, and one of several small peripherals.

In the same performance class as Digital Equipment Corp.'s middle-range PDP-11/34, the system will range in price from about $10,000 to $100,000 and is aimed at users—either end-users or original-equipment manufacturers—who need little support in applications programing. However, in contrast with other suppliers of minicomputers to OEMS, IBM says it will not offer quantity discounts on the system. "The price will be the same to all, large and small," says C. B. Rogers Jr., IBM vice president and president of the General Systems division, Atlanta, developer of the Series/1.

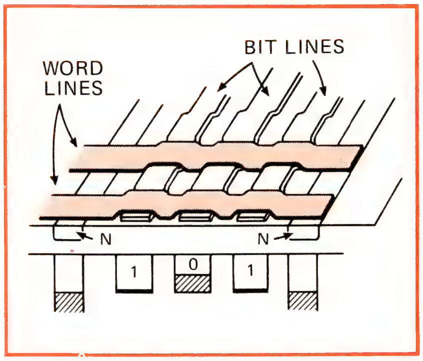
However, the lack of a discount schedule, apparently imposed by company policy, may present problems in competing in the price-sensitive market for machines used by OEM system houses. Here, IBM will have to rely on its reputation for service and support and "that nice warm feeling that dealing with IBM can give you," says one industry observer.

Complete series. IBM's Series/1 minicomputers include processor, fixed disk, and floppy disk in one 19-inch rack, plus a CRT display and serial printer as two separate units.

As for the minicomputer makers, they are adopting the expected wait-and-see attitude. The IBM announcement "has not tempered our expectations for continued growth and could possibly serve to expand markets for all suppliers," says a statement from Digital Equipment in Maynard, Mass.

Norman Zimbel, head of the distributed-systems unit at Arthur D. Little Inc., Cambridge, Mass., points out that IBM's earlier minicomputer product, the System/7, has been in need of replacement for a couple of years "and was never a comprehensive minicomputer product. The Series/1 will undoubtedly be a comprehensive line. And it's clear they'll try to differentiate their product by the level of service they offer."

Two types of central processing units are offered, both based on IBM's large-scale-integrated TTL. Model 3 has a storage cycle time of 800 nanoseconds, and model 5 has a 500-ns cycle time. Memory comes in 16,384-byte increments, from 16 kilobytes to 65,536 bytes in model 3, and from 16 kilobytes to 131,072 bytes for model 5. Average instruc-



Memory. Diffused n region supplies charges to potential wells. Half-full wells are logic 0s, nearly empty wells are 1s.

transistor altogether. They are combining charge-coupled-device-like principles with standard n-channel metal-oxide-semiconductor processing to reduce the three principle elements of a RAM cell—word line, bit line, and storage electrode—to only two elements.

The result is a memory cell defined by the simplest of structures—the intersection of two conductors. One is the word line, and the other is a combined bit line and storage electrode. H. S. Lee and W. D. Pricer, engineers at IBM's Essex Junction, Vt., facility, will describe the development at the International Electron Devices Meeting in Washington, D.C., next month. At last year's meeting, Al Tasch of Texas Instruments Inc., Dallas, described a similar CCD-like structure that combined storage and switching elements under one CCD gate [*Electronics*, Dec. 25, 1975, p. 30] and that TI is still developing.

Potential well. In the IBM device, information is stored as minority carriers in a potential well beneath the cross-point of the word and bit lines. The wells are defined by regions of thin oxide between the bit line and the substrate; adjacent storage wells are separated by thick oxide regions in one direction and by the word lines in the other direction.

To write a 0 into the cell, the bit-storage-and-sense line is pulsed to a high voltage (about 10 volts), creating a well that collects electrons from a source of charge, a diffused n^+ region. The potential well fills up to about the halfway mark.

To write a 1, the same line is pulsed to half the previous voltage so that few charges are placed into the well. In reading, more charge flows into the wells. Those that were half filled receive less charge than those that were almost empty. Thus, the bit-sense line picks up higher voltages from the previously empty wells. The reading is destructive, since all wells will be about half filled after the operation.

Small array. So far, only an 8-by-8-bit array has actually been built, but Pricer says that "the chances of success of building a larger array are 100%." The real challenge, he says, is to build fast, high-gain sense amplifiers onto the same chips.

Generally, he says, the array will take up about 30% to 50% of the chip area, while the sense amplifiers, connection pads, and the like will occupy the remaining space.

Although Pricer would not speculate on future devices, it is clear that, since today's photolithography can easily produce lines 5 micrometers wide, each cell in such an array need measure only about 0.16 square mil, and a typical 30,000-mil^2 chip should be able to hold 65,536 bits. (In contrast, a typical one-transistor memory cell measures about 1 square mil, and only 16,384 of them fit on the same size of chip.)

Of course, lines still narrower than 5 micrometers are a not unthinkable goal in the future, and then chip capacity could soar well above 65 kilobits. ☐

Avionics

FAA to test computerized voice response to queries from pilots

Next month the Federal Aviation Administration will begin testing a computer voice-response system to ascertain if it can be used to brief pilots of general-aviation aircraft. The agency intends to determine just how much information the pilots want in planning their flights.

The voice-response system, along with other self-briefing terminals for pilots (see "Brief yourself by computer," p. 44), is being developed for the FAA by the Department of Transportation's Transportation Systems Center, Cambridge, Mass. Paul Abramson, chief of the automation branch in the center's Aeronautical Systems division, says the test

New voice. Weather data is entered into the voice-response briefing system being readied for pilots at the FAA's Transportation Systems Center in Cambridge, Mass.

To every OEM who needs a thin, easily set control meter.

Specify Airpax ER-35 meters. They're only ⅞″ thin, and since they have no protruding barrel, you can stack them side-by-side or top-to-bottom.

Switching is 100% solid-state, for the utmost in accuracy. There are no physical contacts, mirrors, or prisms.

ER-35 meters are available with one or two setpoints. Setting is extremely easy because the levers move along the external face of the meter and can be adjusted over its full range.

What's more, the ER-35 can withstand extreme physical shock. The meter is shielded against outside magnetic influences, and it can be used under adverse environmental conditions.

By now you must be wondering about the price. Relax. In quantity, the ER-35 sells for less than $75.

For more information, circle our number on the reader service card. If you're in a rush, give us a call. We're ready to assist you.

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Circle 45 on reader service card

Sescosem November 1976

Audio amplifiers in the limelight.

Experience gained through continous product development is our main asset. For 10 years our products have been used all over Europe in the whole AF amplifiers field. Innovation in circuit design and packaging is our constant goal.
Proof of this can be found in our latest circuit, the ESM 532C.
Previously using many discrete components, you can now build with this circuit, 30 watts hi fi amplifier complying to the european hi fi standard (DIN 45 500).
A specialized application laboratory, large production capabilities, a european marketing organization are ready to respond to your needs.

	ESM 532 C
V_{CC} max	36 V
I_O max	3,5 A
$R_{Th\ j\text{-}c}$	< 3 °C/W
Thermal protection	
Output current limitation	

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Circle 236 on reader service card

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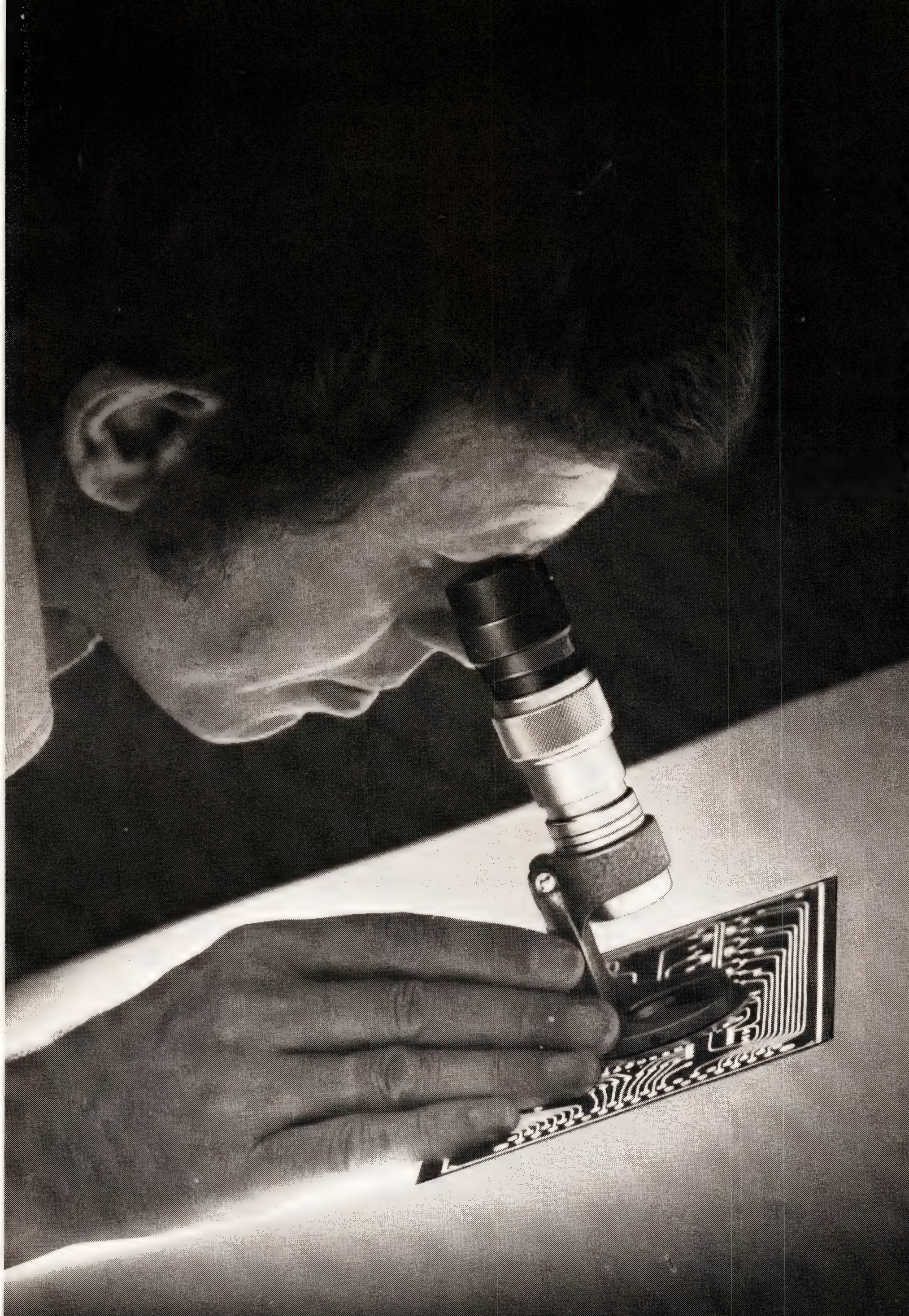
We do not only supply you with film you are getting dimensional stability into the bargain!



A polyester base that got a special treatment... An extremely thin low gel emulsion...
The two together give Copyline HD and HDU film this extreme dimensional stability.
Films that under all circumstances ensure outstanding quality (as well as line sharpness, contrast, capability of being written on, retouchability, etc.).
Our technician will be glad to show you the numerous possibilities. Also in automatic processing, in Copyline AP 126, Rapimat 65 or in a lith processor, dimensional stability will be ensured.

And this is important, particularly in electronics. When making printed circuits, by way of example. As average always some 10 to 12 superposed layers: extremely small and needing scrupulous care.

You start out from drawings (no problems when making them on Copyline drawing film). Then you work by means of photographic techniques, reduced, duplicated on Copyline HD or HDU film.
You will highly appreciate the dimensional stability. For all these films have to fit exactly on each other, without any register differences.
Copyline in electronics: the pat answer!

AGFA-GEVAERT N.V.,
B-2510 Mortsel-Belgium

Circle 237 on reader service card

Agfa-Gevaert service – your security for to-morrow

The HSDC-14 is a thick-film MSI hybrid that opens up a whole new range of operating environments where conventional discrete converters can't stand the punishment. High resolution (14 bits) coupled with ratiometric conversion and Type II tracking servo dynamics (Ka = 58,000), plus a power requirement of only 750 MW add up to superlative performance. The HSDC-14 features, in addition, a DC velocity output signal and requires only a +15V power supply in addition to logic voltage.

Reliability is built into this SEM-compatible unit with MIL-STD-883 Level C or B processing included, assuring the utmost in consistent high-level performance at an accuracy of ±4′, ±0.9 LSB worst case error.

Separating the solid-state control transformer (SSCT) and error processor into two hybrid packages permits great flexibility for other S/D functions such as ECDX and two-speed conversion. Its tiny size (two 0.8″ by 1.9″ by 0.21″ modules) makes the HSDC-14 the ideal converter for remotely located, hard to access equipment where MTBF really counts — where rugged military, avionic and industrial demands can be met only by the finest product there is.

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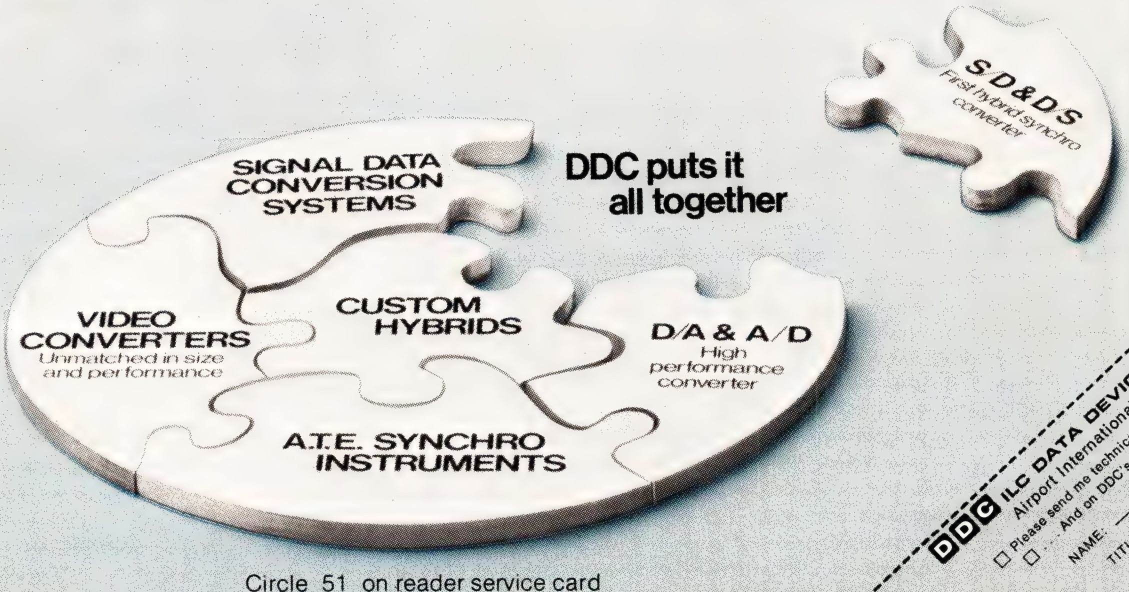
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Circle 51 on reader service card

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vice president of regional activities, and Bayless, director of region VI, are Californians, and both have spent the major part of their IEEE service in regional affairs. Both agree that the situation created by the vote will cause problems, but say that they can work together.

No confidence. For Feerst, who was a petition candidate for president in last year's race, the results were "an overwhelming vote of no confidence in the IEEE board of directors. The board's presidential nominee won with only 44%, the board's vice president lost, and all three propositions, which the board opposed, got over 50%." As a result, Feerst proposed the three persons among the eight appointed to the board of directors: himself to become vice president for professional activities; Fred Schlereth, head of Inficon, East Syracuse, N.Y., for secretary-treasurer, and J. R. Smith of the department of Electrical Engineering, University of Florida, for vice president, educational activities.

In the meantime, Feerst says he's been asked by many of his supporters to consider forming a separate organization of electronics engineers dedicated to professional activities. "At present, all options are open," he says. "But in no way will I stop trying to improve the status of working engineers." ☐

Photovoltaics

Thick films ease contact attachment

By switching from vacuum evaporation to the use of thick-film conducting contacts on silicon solar cells, engineers for a solar-panel manufacturer say they will eventually cut costs by two thirds. "Putting on contacts cheaply is the name of the game in solar cells," says Bill Yerkes, general manager of Solar Technology International Inc., Chatsworth, Calif.

His company has developed a thick-film ink that can be put on at

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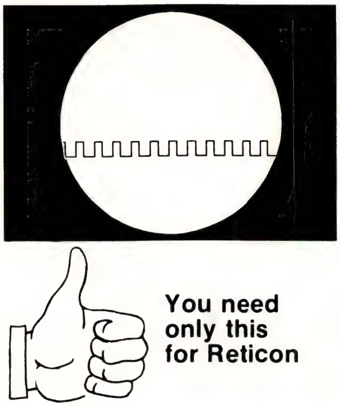
Requiring less than a dollars worth of circuitry to drive—and barely more than that for video processing—is just one of the key features of our new "G" series image sensors. Compare the non-critical single TTL clock needed for the "G" device to the complex multi-phase clocks prescribed by others.



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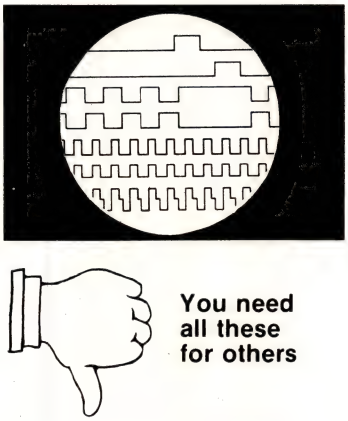

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Or even less will bring you 256, 512, 768, or 1024 sensor elements on 25μ centers or up to 1728 elements on 15μ centers in our "H" series.

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Low dark current allowing low light level operation, on-chip noise cancellation, and smooth spectral response from visible through infrared makes this new generation the unquestionable choice.

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NATIONAL ANTHEM

ALL THE NEWS THAT FITS

A Review of New Products from National Semiconductor

European Edition

PROCESSOR IS CALCULATOR-ORIENTED

Looking for a versatile, low-cost, dedicated or custom-programmable calculator or control system? We've got it! Our MM5799 contains all system timing functions, all arithmetic and logic functions, all RAM functions (384 bits), and all control ROM functions (1536 microinstructions 8-bits wide, 10-μs/microcycle) that you'll need to implement a variety of small control and microprocessor systems.

A single MOS/LSI chip, the MM5799 can scan 56 keyboard switches, or you can enter BCD data words. Its eight outputs present information in either a BCD or a seven-segment-plus-decimal-point format, and four additional latched outputs give you encoded digit-timing information. Further, a serial-in port and a serial-out port let you expand the basic RAM store and interface to peripherals.

And speaking of peripherals and extra storage, our MM5788 printer interface, DS8664 Series oscillator and decoder/drivers, MM5785 RAM interface, and MM2102 and MM74C930 1-K static RAMS are a perfect match to an MM5799-based system.

A special purpose microprocessor, our MM5799 uniquely bridges the gap between the overkill of general purpose processors and inflexible, costly, custom LSI.

Universal Timer Circuit

The MM5865 is a new timing circuit ideal for use in stop watches, kitchen and oven timers, event timers/counters, rally and navigation timers, etc. Its single chip contains all the logic required to control the timer's two 4-digit counters, to compare them, to blank leading zeros, and to cascade another MM5865.

Input-pin functions start, stop, reset, and set the counters, and determine which of the timer's seven functions is to be performed, the display resolution (0.01, 0.1, 1.0 sec., or external clock), and the divide modulo.

The MM5865's seven functions are start/stop with total elapsed time, start/stop with accumulative event time, split, sequential with total elapsed time, rally with total elapsed time, program up-count, and program down-count. The circuit uses either a 32.8-kHz crystal or an external clock, and is packaged in a 40-pin molded DIP.

The New SC/MP II

Over Twice as Fast . . .
Uses only 1/2 the power

SC/MP II, the newest 8-bit single-chip microprocessor introduced by National has all of the features of SC/MP plus operates at twice the speed and with less than 200 mW (typical) power dissipation.

SC/MP II will be completely pin and software compatible with SC/MP, and with slight modifications to the crystal frequencies, will be compatible with all of the SC/MP support from the SC/MP INTROKIT and SC/MP keyboard kit to the SC/MP LCDS (Low Cost Development System).

The new microprocessor, an N-Channel device operates on a single 5 volt power supply and includes features such as:

- **8 bit data handling combined with 16 bit addressing**
- **on-chip clock**
- **serial I/O ports for easy interfacing**
- **build-in flags and jump conditions**
- **an interrupt structure that gives fast response to asynchronous events**
- **a delay instruction to simplify timer systems**
- **a set of 46 control-oriented instructions.**

The on-chip clock is designed to use very low cost (T.V. type) crystals or the user may drive the clock signal by standard TTL compatible timing systems. A limited number of samples have been distributed and a retrofit kit will be made available so that present INTROKIT users can evaluate the new SC/MP II at minimum cost and time.

Because of the forty-pin molded plastic package, SC/MP II prices will be comparable or lower than existing SC/MP devices.

Production quantities will be available February 1977.

And now. . .A full line of Durawatt 92-Plus™ Power Transistors

Durawatt 92-Plus™ . . . National's unique power transistor package concept that actually improves performance *and* reliability while letting you retain a cost-effective design. As described in *National Anthem* No. 1, January 1976, Durawatt 92-Plus packaging eliminates the no-man's land of power transistor usage, that limbo between 800 mW and 2 W dissipation.

Our new, standard line of 92-Plus transistors operates at a solid 1.2 W, and features a 6-W maximum dissipation rating! The series comprises six generic families of general purpose complementary power types and Darlingtons (rated at 2 A/45-100 V), and high-voltage line drivers (100-500 mA/250-300 V)—21 92PXXX types, and only National has them.

Memories. . . at a glance

The accompanying tables present a summary of National's wide range of semiconductor memory products. They show at a glance whether or not we supply a given memory type, its organization(s), and its production status.

The letters in the tables represent memory organizations, as shown in the legend below the tables. Letters without asterisks show memories that are in volume production. The asterisks indicate products yet to enter production, although some of these are already in the sampling phase.

A letter with an asterisk preceded by the same letter without an asterisk indicates that another version of the same device is to be put into production. The second version may differ from the first in speed, pin-out, number of leads, etc. Keep in mind, too, that a single letter entry in the tables may represent a number of product types differing, again, in speed, pin-out, number of leads, etc.

In addition to the memory products shown in the tables, National supplies shift registers, PLAS, character generators, code converters, etc. Full information and specifications for our complete line of memory products will be found in our *Memory Data Book*

TOTAL BITS	RAMS			
	MOS (static)	MOS (dynamic)	CMOS	BIPOLAR
64			C	B,C
256	D		D,E	D
1024	G,I,I*		G,G*,I	G*
4096	P*,O*	O,O*		

TOTAL BITS	PROMS/EPROMS	
	MOS	BIPOLAR
256		F
1024		I
2048	M,N	M,M*,N
4096	P,Q,Q*	P*,Q,Q*

TOTAL BITS	ROMS	
	MOS	BIPOLAR
256		F
1024	I,J	I
2048	M,N	M,N*
4096	P,P*,Q,Q*	Q
8192	R*,S	S
16,384	U*,V*	V,W

Organization Codes

64 bits

A = 64 x 1
B = 32 x 2
C = 16 x 4

256 bits

D = 256 x 1
E = 64 x 4
F = 32 x 8

1024 bits

G = 1024 x 1
H = 512 x 2
I = 256 x 4
J = 128 x 8

2048 bits

K = 2048 x 1
L = 1024 x 2
M = 512 x 4
N = 256 x 8

4096 bits

O = 4096 x 1
P = 1024 x 4
Q = 512 x 8

8192 bits

R = 2048 x 4
S = 1024 x 8

16,384 bits

T = 16,384 x 1
U = 4096 x 4
V = 2048 x 8
W = 1024 x 16

National Semiconductor
is at Electronica 76
in Munich, Nov. 25-Dec. 1
Hall 14
Booth 14509

Bi-FET™ Sample/Hold:

Fast Acquisition, Ultra-High Accuracy, Low Droop Rate

The headline tells the story. National's BI-FET™ technology, which combines FET and bipolar devices on the same chip, first yielded fantastic new op amps (*National Anthem* No. 1, January 1976). Now BI-FET technology yields new sample-and-hold circuits: dc gain accuracy of 0.002% (typ.) in a unity-gain follower configuration; acquisition times as low as 6 μs to 0.01% with a 1000-pF hold capacitor; droop rates as low as 5 mV/minute with a 1-μF hold capacitor!

We're talking about our LF198/298/398, which eliminate input/output feedthrough in the hold mode even for signals equal to the supply voltages—±5 V all the way to ±18 V. In addition, these parts feature a single-pin input offset adjustment that does not degrade input offset drift; an input impedance of 10^{10} ohms, which means that high source impedances will not degrade accuracy; a bandwidth sufficient to allow stable insertion of these circuits within the feedback loop of 1-MHz op amps; and a TTL/PMOS/CMOS-compatible logic input . . . all contained in a little, 8-pin, TO-5 metal can.

National Semiconductor . . . Making Technology Work

Digital calendar-clock circuits

The MM5382 and MM5383 digital calendar clock circuits provide the timing, control, and interface circuitry for a minimum-cost, solid state, digital clock radio.

The circuits have four display modes: time; alarm; date; and sleep—as well as a four-year calendar display. The timekeeping function operates in either a 12-hour or a 24-hour mode. The MM5382 is the 12-hour version, and has a month-date format; the MM5383 is the 24-hour version, and has a date-month format.

Outputs consist of a presettable 59-minute sleep timer (e.g., a timed radio turn-off) and an alarm tone. A power failure indication warns the user that the time displayed may be in error.

Other features include: alarm display; brightness control; 24-hour alarm set; PM indication; fast and slow set controls; and a nine-minute snooze alarm. (The MM5383 has an alarm ON indicator.) Both circuits provide open drain outputs for the direct drive of LED displays to 15 mA.

New Pressure Transducer Housings are Second Generation Designs

Our new housings for the LX1700 series pressure transducers create small and lightweight, yet rugged, alternatives in pressure transducer packaging. Designated the PX7-1 (a zinc casting) and PX7N-1 (in nylon), these new packages, in combination with the LX1700 transducers, are well suited to applications such as air conditioning and refrigeration compressor control, compressed-air tank monitoring and control, gasoline and diesel engine diagnostics, 3–15 psig pneumatic measurement and control, etc.

The housings are available in absolute, gauge, and differential (PX7D-1, nylon) configurations for pressure ranges from ±5 psi to 0–300 psi. Mechanical features include an internal, captive O-ring seal, and a 1/8" NPT male pressure connector. A 13-inch cable for electrical connection makes testing easy; the 5-pin connector at the cable end is keyed, locked, and strain relieved.

A drove of (peripheral) drivers

National's interface products include a variety of circuits to solve peripheral drive problems of all kinds. For example, if you need a high voltage (30 V), high current (300 mA), high speed (25 ns) driver with TTL inputs, then try our DS75450 series. These dual peripheral drivers have AND, NAND, OR, and NOR input configurations, and work nicely as power drivers, relay and lamp drivers, bus and memory drivers, etc.

Or, if you can sacrifice high speed for low cost, look into our DS75460 series of dual peripheral drivers. These circuits are functionally interchangeable with the DS75450 described above, but are rated at 65 ns, and are designed for applications that require a higher breakdown voltage (35 V).

If you've had latch-up problems and would like to broaden your system's operating margins, then our DS3611 series is for you: 300-mA sink capability; 80-V breakdown; and no latch-up even at 55 V. The circuits are functionally interchangeable with the DS75451 through DS75454.

How about driving power from CMOS? Our DS3631 family of dual peripheral drivers does it, sinking 300 mA and withstanding 56 V at the outputs. Other features include CMOS-compatible pnp inputs; low V_{CC} dissipation; output circuit protection against V_{CC} loss; and operation between 4.75 V and 15 V. Pin-outs are identical to those of the DS75451, DS75461, and DS3611 series.

Finally, there are our telephone relay drivers—the DS3686 and DS3687. Both are duals rated at 65 V and 300 mA. The DS3686 is a positive-voltage driver; the DS3687, negative.

You'll find complete information and specifications for these and many other products in our 464-page *Interface Data Book*

Low-Cost Development System for SC/MP Microprocessor

The SC/MP Low-Cost Development System (LCDS) is a simple-to-use controller that provides a maximum of flexibility at a minimum—and very affordable—cost. It has everything needed to develop and test SC/MP hardware and software designs for your applications.

LCDS features easy interfacing and expansion. Four prewired edge connectors, for example, provide a plug-in interface for SC/MP family cards, and also let you interconnect additional SC/MP applications hardware. (There's room for a fifth connector, too, if you wish to add it.) You can also add a flat cable connector for coupling the LCDS to an external card cage.

Built-in control and monitor functions permit transfer of control between the LCDS resident firmware—subroutines that let you enter software debug commands via the control and display panel, or an optional Teletype®—and your own application programs.

Expansion is easy, too, because of the cards offered for use with the LCDS. The 2K × 8 read/write memory and 4K × 8 ROM/PROM cards, for example, provide additional memory: just plug them into the card bus.

The minimum LCDS comprises a SC/MP CPU card, scratchpad memory, ROM-based firmware, and control logic. Also included are a 16-key dual-function hexadecimal keyboard, all necessary function keys and control switches, and a six-digit hexadecimal display.

With the basic LCDS configuration alone, you can examine and alter the SC/MP registers and memory locations, run SC/MP programs in continuous or single instruction mode, and even operate with an optional Teletype using SC/MP DEBUG.

N8080 family rounds out National's microprocessor line

National's line of microprocessors is now the broadest in the industry: to the ranks of our bit-slice IMP, 16-bit PACE, 8-bit SC/MP and 4-bit FIPS, we have added our new N8080 family. Well suited to the broad spectrum of general purpose microprocessor applications, the 8-bit INS8080A CPU fits neatly between our cost-effective 8-bit SC/MP and the versatile 16-bit PACE CPUS.

The INS8080A CPU, with its full line of support circuitry, offers you a family approach to system design, multiple source availability, and total product support from National—RAMS, ROMS, PROMS, I/O components, and a wide variety of linear and digital interface circuits.

In addition, we are backing our N8080 family with a full range of development tools, both hardware and software, for quick and easy assembly of basic design kits and implementation of development systems.

NEW TRI-STATE® OCTAL BUFFERS Use Low-Power Schottky Technology

Four new Tri-State® octal buffer ICs that employ low-power Schottky technology are now available in quantity from NSC. The DM81LS95/96/97/98 provide eight, two-input buffers in a single package. One of the two inputs is a control line that gates the output into the high-impedance state, while the other input passes the data through the buffer. Typically, power consumption is less than 80 mW per package with propagation delays less than 13 ns.

The DM81LS95 and 97 present true data at their outputs; the DM81LS96 and 98 invert the data. The DM81LS95 and 96 have eight common Tri-State enable lines, accessed through a two-input NOR gate. The DM81LS97 and 98 have two groups of four buffers each, each enabled by its own common line. Both commercial- and military-grade versions are available from stock.

WOW! 12-Bit Binary and 3-Digit BCD DACs

Brand new from National . . . a family of precision, low-cost, digital-to-analog converters for a wide range of industrial and military applications. Our DA1200 Series is self-contained in a 24-pin DIP (molded or hermetic); just turn them on and they're ready to go to work for you.

General features of the new DACs include both current- and voltage-mode outputs (0-2 mA, 0-10 V, ±10 V); ±½ LSB (binary), ±½ LSD (BCD) linearity; 1.5-μs current-mode, 2.5-μs voltage-mode settling times; precision, buffered, internal references (10.240 V binary, 10.000 V BCD); standard power supplies (±15 V, +5 V); TTL/CMOS-compatible, complementary binary or BCD input-logic formats; and expandability to 14 or 16 bits.

The DA1200/DA1201 are the 12-bit binary devices; the DA1202/DA1203 are the 3-digit BCD devices. Terrific specs, terrific parts. Ask for the data sheet and you'll see what we mean.

National Semiconductor
is at Electronica 76
in Munich, Nov. 25-Dec. 1
Hall 14
Booth 14509

National Semiconductor . . . Making Technology Work

Washington newsletter

Litton asks FCC for 10.6 GHz for microwave ovens

A new line of microwave ovens heated by an "inexpensive magnetron" at 10.6 gigahertz is now in preliminary development by Litton Systems Inc. of Minneapolis. That disclosure is in a petition Litton has filed with the Federal Communications Commission requesting the 10.5 – 10.7-GHz band for microwave ovens. Existing ovens operate at 2,450 megahertz, but Litton says **a shorter wavelength would cook food more uniformly** by reducing "overcooked spots adjacent to raw spots" in such foods as cakes and would also brown food surfaces better, since energy at 10.6 GHz does not penetrate as deeply into foods as it does at 2,450 MHz.

Cooking though, would take longer because of the shallower penetration. To overcome that drawback, Litton senior staff engineer Harold C. Anderson told the FCC, "An oven with a combination of 2,450 or 915 MHz [with 10.6 GHz] could be made." Anderson also said adherence to the rigid radiation limits for microwave ovens should preclude 10.6-GHz ovens from interfering with other equipment at that frequency—including approximately 8,000 continuous-wave police radars operating at 10.525 GHz.

Radiation limits eased by FCC for CB rebuilds . . .

Manufacturers can upgrade their 23-channel citizens' band transceivers to 40 channels with less difficulty after Jan. 1, now that the Federal Communications Commission **has eased its chassis-radiation requirements for sets already in inventory by Nov. 1.** In so doing, the FCC has granted part of an Electronic Industries Association petition to reduce the chassis-radiation requirement from 5 microvolts per meter at 3 meters from the chassis to 50 μV/m, but the tougher 5-μV standard remains unchanged for new 40-channel CBs.

The FCC refused altogether to back off on its requirement that all remanufactured models must contain a phase-locked loop, just like the new 40-channel transceivers that go on sale Jan. 1. This means that only "about 50% of the 23-channel sets can qualify for upgrading," says the EIA's John Sodolski, Communications division vice president. Rebuilt sets marketed under the waiver must be labeled to that effect, the FCC says, and all such sales must end by Jan. 1, 1979.

. . . 1976 CB sales of 10 – 12 million seen as plateau

In the year-end sales countdown, 1976 citizens' band radio volume is expected to **double last year's record in both units and retail dollars,** rising to an estimated 10 million to 12 million transceivers worth approximately $2 billion. That is the forecast of Electronic Industries Association vice president John Sodolski, who said in an interview that November and December sales of 23-channel class D sets will soar to "unprecedented levels," now that price-cutting "appears to have touched bottom" prior to January's introduction of new 40-channel units [*Electronics*, Aug. 5, p. 49].

The EIA executive's best guess on the ultimate size of the U.S. market is that 50 million units will be in operation within five years, and annual sales will stabilize near the 1976 level. About 70% of all CBs are now imported, mostly from Japan. And in the FCC's first approvals of 40-channel CBs for sale—25 models from 20 companies—all are made offshore. Radio Shack leads with three models, followed by Sears, Roebuck & Co., Teaberry Electronics Corp., and Kraco Enterprises with two each. Among the 16 other makers winning approval of single models is Toyota Motor Sales U.S.A. Inc., which will offer its CB as an option in new cars.

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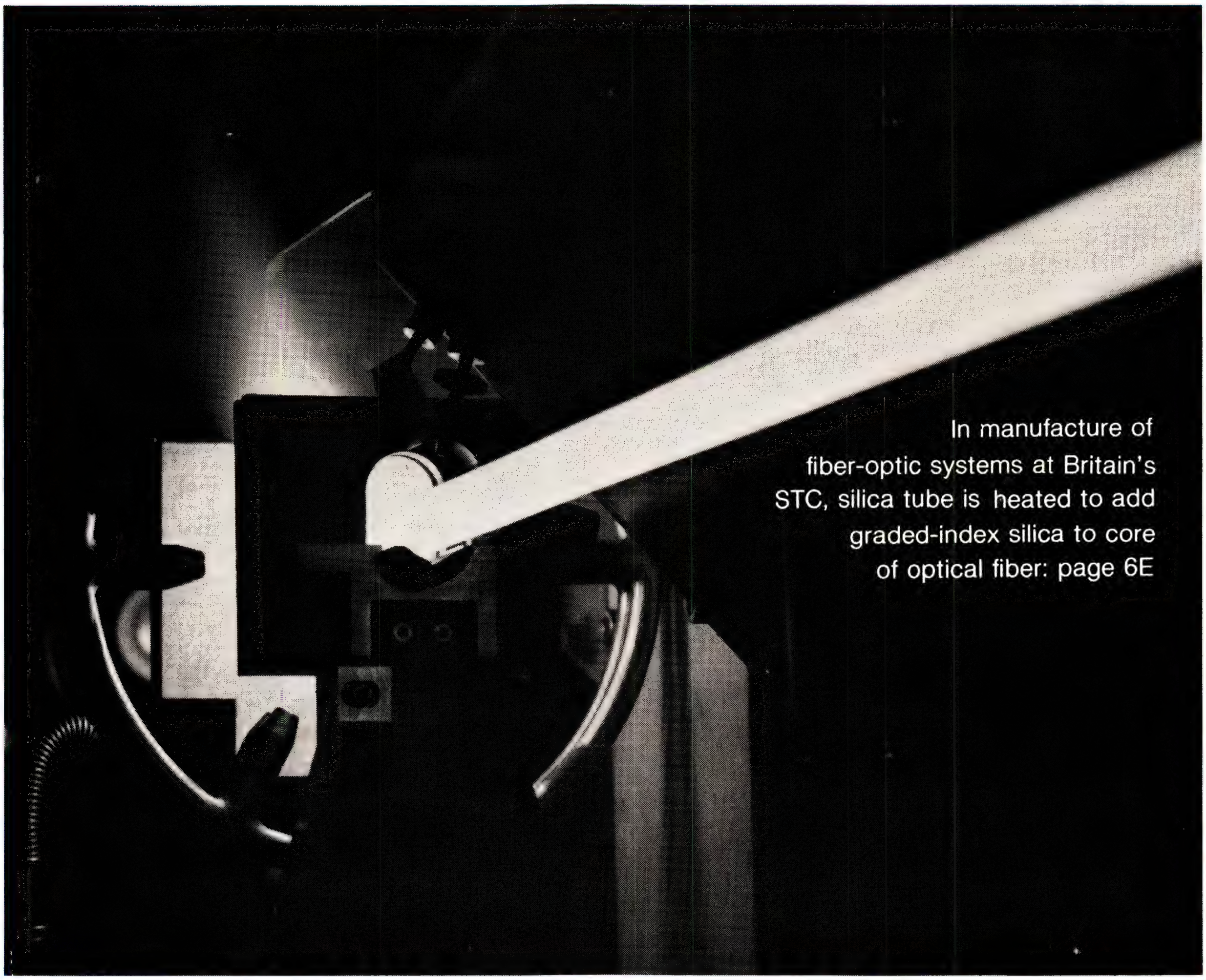
ELECTRONICS CF - G2-5/6-2

Circle 242 on reader service card

Electronics
International
Nov. 25, 1976

Luxembourg company plans to market first VDR: page 5E



In manufacture of fiber-optic systems at Britain's STC, silica tube is heated to add graded-index silica to core of optical fiber: page 6E

France pressures ITT firm to export more phone switches

Trouble is brewing between France's minister of Postes et Télécommunications, Norbert Ségard, and ITT subsidiary Compagnie Générale de Constructions Téléphoniques. The French minister is demanding that CGCT step up its exports to 50% of its total production of electronic switches in order to increase France's share of international telecommunications sales. The company, which exported more than $60 million worth of switching equipment last year, **claims the PTT is being unfair in that it is not requesting France's other telephone-equipment manufacturers to meet the same requirements.** CGCT, which says Ségard is making the demands for political rather than economic reasons, contends that it already accounts for 70% of the country's switching exports.

Ségard is also asking ITT to separate its French operations from its main European headquarters in Brussels in an apparent attempt to further Frenchify CGCT. The French government recently forced ITT to sell its other French subsidiary, Le Matériel Téléphonique, and there is speculation that Ségard is trying to gain increasing control over CGCT.

Telephone, rail rate boosts augur business in Japan

Long-awaited passage of bills to increase the rates for Nippon Telegraph and Telephone Public Corp. and fares for Japanese National Railways should boost business for communications-equipment manufacturers. **In addition, the nation's Council of Economic Ministers has decided to revive some construction projects deferred by NTT and JNR.**

The delay in the rate increase from June 1 to Nov. 17 had caused NTT to defer $1.55 billion worth of construction, most of the $1.69 billion in income it figures it lost by the delay. Included in the deferment were 750,000 of the 2,600,000 phones to be added this year. The government plan will allow NTT to revive about $1 billion worth of construction, including all 750,000 phones deferred. About $570 to $610 million of this will come from subscribers, obligatory debentures, and installation fees. The remainder will be a government loan that must be approved by the Diet, which will meet late in December. The **new NTT rates include a 150% increase in basic monthly charges, a 43% jump in message-unit fee, a 200% boost in the telegraph rates, and a 60% increase in the installation fee.** On April 1, the basic monthly charges will be boosted 200% above the original rate.

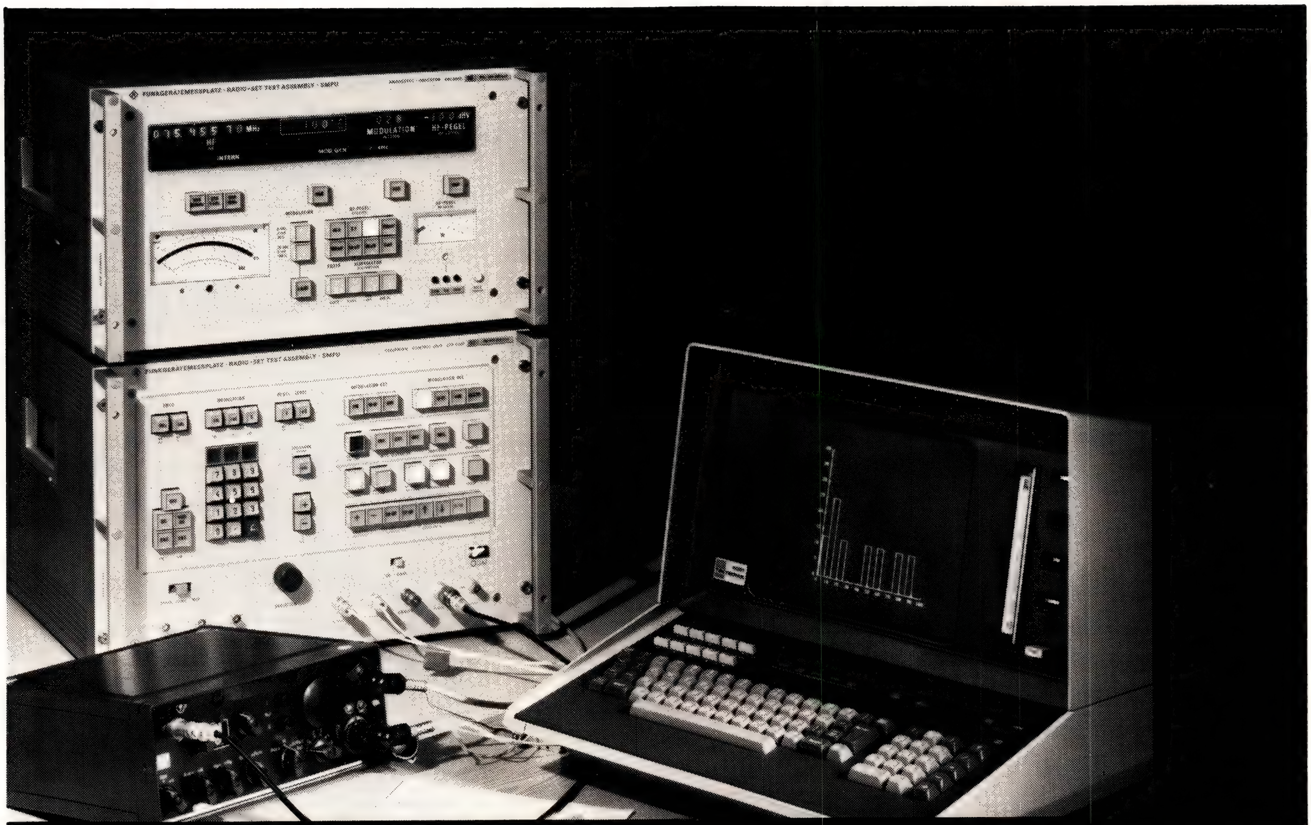
German auto radar has microprocessor to warn driver

Standard Elektrik Lorenz AG, a German ITT affiliate, is testing a microprocessor-based anticollision radar system for cars. A 2° beam from a radar mounted at the front of the car detects objects in its path. At the heart of the system is an 8080 microprocessor programed to distinguish moving objects like people from stationary ones like traffic signs. Only potentially dangerous objects trigger the alarm, which warns the driver and indicates the direction of the threat. **The program ensures that only relevant echoes are processed and that "meaningless" echoes are prevented from triggering the alarm to warn the driver.**

UK firm announces monolithic 2.45-V reference source

A low-cost precision 2.45-volt reference source that has been made into a two-pin monolithic package is being announced by Ferranti's Electronic Components division at this month's Electronica exhibition in Munich. Aimed primarily at the expanding linear-mode power-supply market, the ZN458T has a temperature coefficient from 30 to 100 parts per million

SMPU: Radiotelephones measured automatically



"Intelligent" Test Assembly with IEC bus rationalizes production and servicing

The Radio-Set Test Assembly SMPU with its built-in microcomputer enables automatic measurements without external control equipment. Operation is extremely simple and easy to understand.

The accuracy of the built-in measuring instruments provides for testing of RT equipment in accordance with **CEPT standards.** And all incorporated measuring instruments are separately accessible so that module testing is also possible.

Programming is performed in line with the **IEC-bus** standard. Thus system extension by additional test and control equipment is easy and adaptable to immediate needs. With the **Card Reader PCL,** for instance, settings and data can be entered using program cards. Combining the SMPU with IEC-bus-compatible calculators such as the TEK 4051 creates a system with all the advantages of computer-controlled automation:

- No restriction to fixed programs
- High "intelligence" for program execution and data logging, including **error diagnosis** and **dialogue** with the calculator
- Extreme ease of program modification and possibility of linking peripherals, such as plotter and high-speed printer.

The SMPU's "intelligence" considerably simplifies the preparation of programs, which are set up by merely calling the individual measurements. No special programming language has to be learnt for operating the assembly.

Ask for the data sheets "SMPU" and "SMPU with desk-top calculator"

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Circle 253 on reader service card

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Only Philips offer a full range of camera tubes for each and every TV need, thereby ensuring unbiased advice for *your* individual application. For example :
Broadcasting. Good colour fidelity combined with high sensitivity and low lag have made the Plumbicon* tube the industry standard for both studio and outside broadcasting. New Plumbicon developments include the combination of extended red response and an anti-comet tail gun plus smaller tube sizes to meet all broadcast and video software requirements.
Surveillance. Here Philips offer a wide choice of tubes and technologies to meet the differing needs of industrial and commercial CCTV. The vidicon for low budgets and high light levels. For reduced light levels the silicon vidicon and the Newvicon*, a new heterojunction tube with virtually no highlight blooming. And for night viewing the intensified silicon vidicon (ISV) tube.
Medical. If it's colour CCTV it's the Plumbicon tube. For X-ray TV the Philips range includes the high resolution Newvicon tube and the vidicon for surgical applications, plus the fast response Plumbicon tube for clinical work.
Education and research. For low budget monochrome systems we offer the vidicon or Newvicon. For educational colour TV the 1" and 2/3" Plumbicon tubes. And for special R & D applications, tubes such as the "Pyroelectric Vidicon" for thermal imaging or the Plumbicon/Image Intensifier combination for very low light levels.

For more information and unbiased advice on any aspect of TV camera tubes please write, stating your application area and performance needs, to :

Philips Industries,
Electronic Components and
Materials Division, Eindhoven,
The Netherlands.

*Trademarks for TV camera tubes

Your guide to TV camera tubes

Parameter / Standard sizes	Plumbicon	Newvicon	Silicon Vidicon	Vidicon	ISV tube	Plumbicon Image Intens.
Standard sizes	1¼"; 1"; 2/3"	1"; 2/3"	1"	1"; 2/3"	1"	1"
Sensitivity **- white** **- near infrared**	medium fair	very high medium	high good	fair fair	extremely high medium	very high medium
Resolution	medium	good	fair	good	fair	medium
Dark current	very low	medium	medium	fair	medium	very low
Temperature dependence of dark current	not dependent	dependent	dependent	dependent	dependent	not dependent
Lag	very low	medium	low	noticeable	low	very low
Burn-in resistance	good	good	excellent	fair	excellent	good
Blooming	hardly	hardly	very noticeable	noticeable	hardly	hardly
Suitability for colour cameras	excellent	medium	fair	medium	fair	good

PHILIPS Electronic
Components
and Materials

PHILIPS

First VDR comes from Luxembourg to annoy giants

Magnetic Disk Recording set to launch system in July for $700, and two-hour disks will sell for $11

While consumers and producers await the battle between optical and capacitive long-playing video-disk recorders, one small manufacturer in Europe is betting it has the key to outselling the industry giants. Magnetic Disc Recording, a holding company based in Luxembourg, plans to get to market first next July with its MDR L 522, a video-in, video-out magnetic-disk system that will retail at $700.

The system includes a video recorder and receiver, a 20-watt-per-channel stereo amplifier, and a radio tuner. Significantly, the disks, which can record two hours of video on each side, will retail for only $11, a price competitive with audio disks in the European market.

Industry observers agree on one thing when it comes to video disks: whoever reaches the consumer first with a long-playing, reasonably priced system has a good chance of scoring substantial market penetration. MDR, which has main offices in Paris, Zurich, and Nürnberg, claims that 200,000 L 522 recorders have already been ordered by one European distributor and that other international firms have also expressed interest in the system.

Experience. Even though larger competitors like RCA, Philips/MCA, and Thomson-Brandt will not get their systems to market as soon, they have already had considerable experience in constructing and distributing audio/visual sets. In contrast, five-year-old MDR is relatively inexperienced.

"The one stumbling block to our success could be the ability to manufacture and distribute in sufficient quantity," admits MDR president Louis-Philippe Rebboah. The firm is still looking for someone to manufacture and distribute the L 522 in the United States.

"Everyone will be attempting to sell video-disk systems in the next few years," predicts Rebboah. He contends that disks will hit the consumer with an impact similar to the advent of television. "But, so far, we're the only company to manufacture a system that both records and plays on disks that are reasonably priced. The competition still plans to concentrate on pressed disks."

Versatility. The MDR unit, which can receive video input by cable directly from either a TV set or a video camera, is designed to work with PAL, Secam, or NTSC television standards. The video bandwidth is 2.5 megahertz, frequency response is 80 hertz to 13 kilohertz, and the audio range is 20 Hz to 29 kHz.

The key to the recorder is the disk itself. A magnetic head, which MDR

Magnetic Appeal. Magnetic video-disk recorder is to be launched in July by Luxembourg firm ahead of optical and capacitive systems of industry leaders.

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Including:
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— values	from 1 Ω	to 1.5 MΩ
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— tolerances	from 1 %	to 5 %
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Circle 256 on reader service card

bands by a series of eight frequency-multiplexing modules. Each module contains 16 ports of 560-megahertz bandwidths each, and each port can handle 7,600 telephone calls.

A terminal station synchronizes pairs of incoming pulse streams, transmitted at 140 megabits per second, or 1,920 telephone circuits, to a common rate and then interleaves them to give a bit rate of 293 Mb/s. More information also is added so that the error rate can be monitored. An Impatt diode source in the transmit head directly modulates the carrier for high output power and a clean spectrum.

At the receive terminal, the carrier signal is down-converted to an intermediate frequency of 1.4 GHz and passed through a delay line to smooth out the systematic group delay common to waveguides. To avoid the problems inherent in carrier recovery common to synchronous demodulation, Marconi neatly uses differential demodulation. The signals are then regenerated, separated, and decoded to produce the original 140-Mb/s pulse streams. The overall system is designed to give an error rate of less than 1 in 10^9/100 km. ☐

Japan

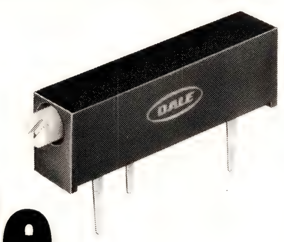
Toshiba builds n-MOS register/ALU

A combination register and arithmetic/logic unit (RALU) containing 2,400 gates has been fabricated with enhancement/depletion n-channel MOS technology on a substrate of silicon on sapphire. The engineers who developed the experimental RALU at the Toshiba Research & Development Center in Japan believe they can eventually build superior commercial SOS microcomputers. Their next step is to build a 5,000-gate device that is effectively a 16-bit minicomputer on a chip.

Begun in 1973, this R&D project is one of many in a large-scale program to develop a system for pattern-information processing that is being funded by Japan's Ministry of International Trade and Industry [*Electronics* International, Sept. 13, 1971, p. 13E]. A general-purpose commercial product probably will not be forthcoming for as long as a year after the scheduled completion of the contract in March 1978.

Local storage consists of 16 16-bit registers, two 4-bit address-stack pointers, and an increment/decrement circuit of addresses. The ALU can load, store, add, subtract, reverse subtract, AND, OR, shift left or right, branch, and halt.

The n-channel enhancement/de-



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Sescosem
November 1976

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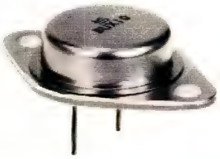
BUX 20 to 25
250 W

TO - 3
BUX 10 to BUX 15
150 W



TO - 3
BUX 39 to BUX 45
120 W

TO - 66
BUX 59 to BUX 65
70 W

TO - 39
BUX 49 to BUX 55
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Thermal fatigue > 10 000 cycles

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Circle 262 on reader service card

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BUNKER RAMO **AMPHENOL**

New products international

20-watt audio amplifier IC offers high fidelity

by Joel Stratte-McClure, McGraw-Hill World News, Paris

Harmonic distortion is less than 1% at full rating and only 0.1% at 10 watts in Sescosem power device

Power devices have come in for a lot of attention over the past few years at Sescosem, the semiconductor division of Thomson-CSF. So the firm's introduction this month of a 20-watt audio amplifier integrated circuit was hardly a surprise.

Although not the first to hit the market with a 20-w audio IC [*Electronics*, June 13, 1974, p. 3E], Sescosem is convinced its new ESM532C has what it takes to become a best seller. The large German manufacturer that asked Sescosem to design the package has already purchased 1 million units to use in consumer products—probably hi-fi systems and tape recorders. The IC will go on the general market early next year and sell for between $1.60 and $2, depending on quantity. "We will produce more than 3 million audio ICs of this type next year," predicts Yves Thorn, Sescosem's assistant marketing manager.

Supporting Thorn's optimism are the impressive specifications of the ESM532C. At the full 20-w rating and a 4-ohm load, the harmonic distortion is less than 1%. At 10 w, the distortion drops to less than 0.1%. These figures put the device in the high-fidelity class. Frequency range is 15 hertz to 30 kilohertz.

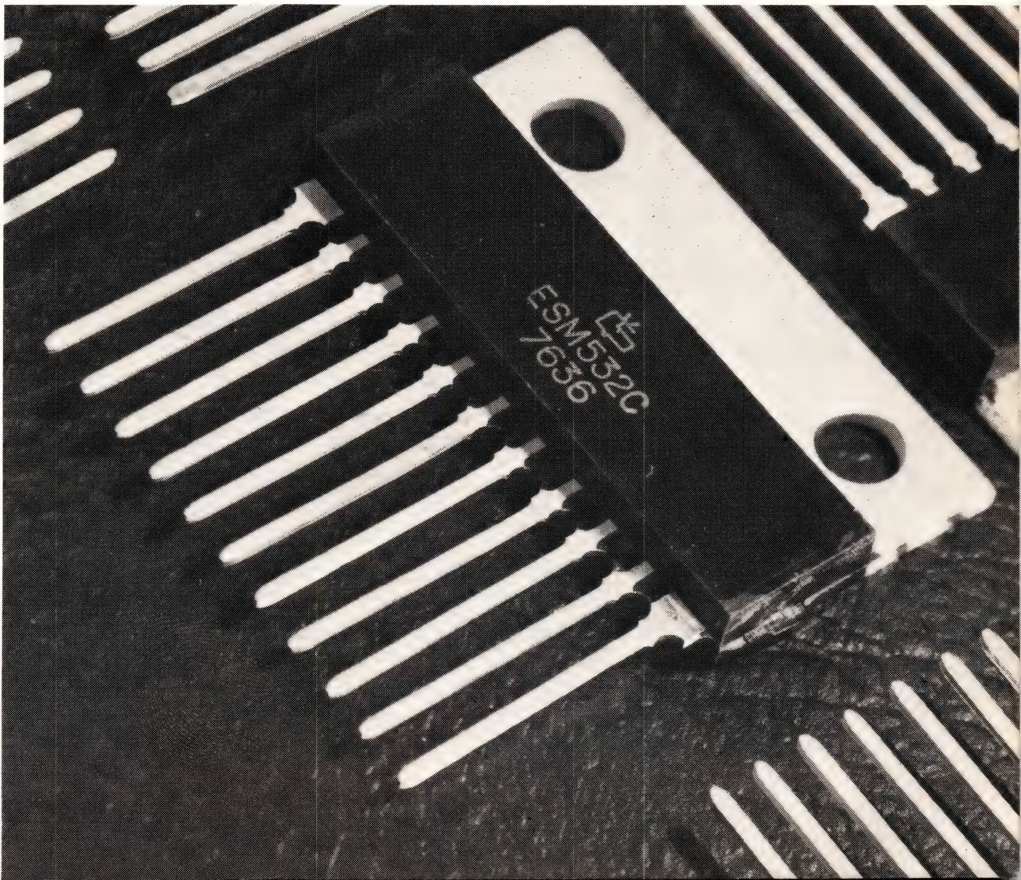
With its two differential input terminals and one output terminal, the device resembles an operational amplifier. Its high-voltage technology permits integration of power transistors with 40-volt breakdown voltages and ±3.5-ampere collector currents. Sescosem says it has reached this high breakdown level by optimizing a proprietary epitaxial process that keeps both resistivity and thickness down.

In order to prevent damage by overheating, Sescosem designed into the chip a bootstrap shutdown circuit that is tied to the output terminal. The circuit continuously measures output current and temperature and diverts excess current to ground when the junction temperature edges past 100°C.

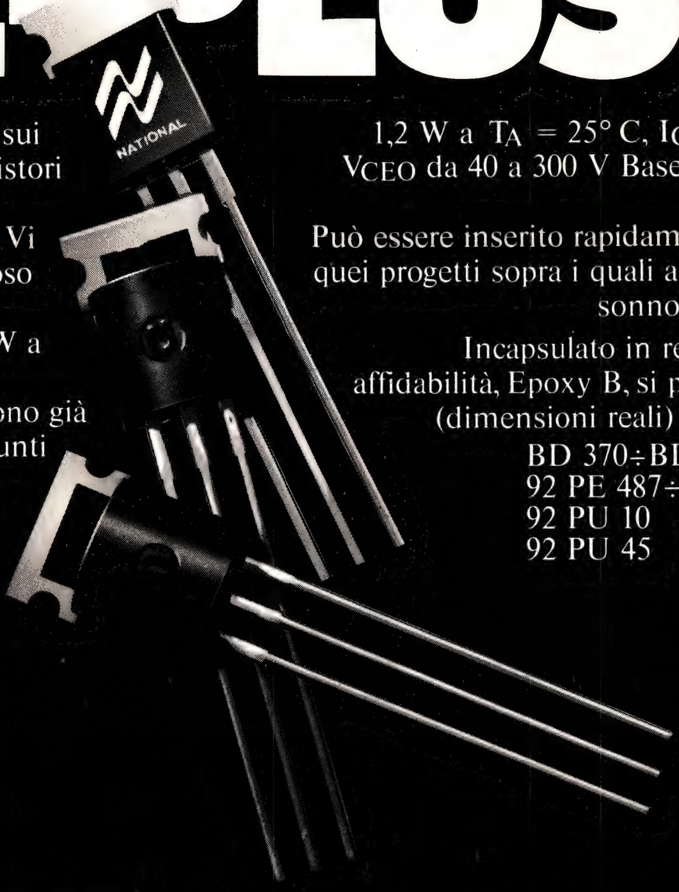
To be sure, competing audio ICs that meet DIN amplifier standards can match the ESM532C's performance. Where Sescosem figures it has the edge is in its power in-line plastic package. It is small—29.5 by 16 millimeters, with a maximum depth of 5 mm—mounts as easily as any other in-line package, and continuously dissipates up to 20 w peak sine-wave power. The thermal resistance is less than 3°C per watt.

In the new package, Sescosem has done away with the intermediate layer of Kovar used in conventional packages to provide a thermal expansion match. Instead, the chip is soldered directly onto a thick copper lead-frame that is attached to the external fin. The soldering method is similar to that employed in the company's plastic power transistors.

Because there is plenty of pinout,



NATIONAL DURAWATT 92-PLUS



E' capitato anche a Voi? Restrizioni sui costi Vi imporrebbero l'uso di transistori economici quali il TO92, mentre necessità di dissipazione di potenza Vi costringono ad utilizzare il più costoso SOT 32.
Il TO92+ è la salvezza! Fino a 1.2 W a $T_A = 25°$ C.
Undici serie diverse di transistori sono già disponibili ed altri ne vengono aggiunti quotidianamente.
Fino ad ora NPN, PNP, NPN Darlington...

1,2 W a $T_A = 25°$ C, I_C fino a 2 A, V_{CEO} da 40 a 300 V Base o collettore centrale.
Può essere inserito rapidamente in tutti quei progetti sopra i quali avete perso il sonno fino ad ora.
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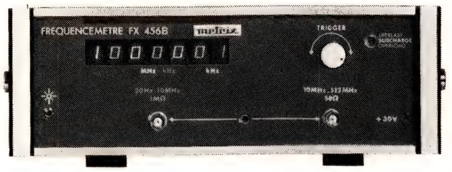
Circle 265 on reader service card

The modular way is four ways better with the Metrix Mobile Radio Test Set

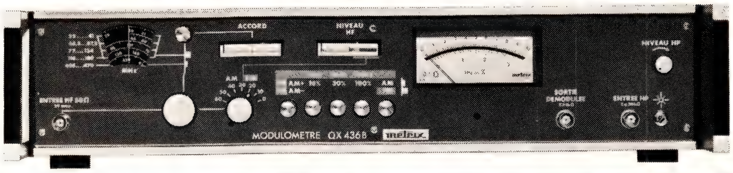
- measures all parameters in duplex mode
- better individual instrument performance
- ability to acquire complete set or individual instruments
- better overall price/performance ratio

Modular is better because it gives you a wide choice of options that make sound economic and functional sense to operators of mobile radio networks. As a first option you can acquire a complete test set for measuring frequency, deviation or modulation depth, and power on the transmitter; frequency and sensitivity on the receiver. And, because Metrix chose the modular approach, you can operate the set in duplex mode to make simultaneous measurements of transmitter power and receiver sensitivity on different frequencies.
As a further option you can add a Metrix digital synchronizer (not illustrated) to phase-lock the generator for very low drift. You get the same stability as the frequency counter quartz oscillator while the excellent spectral purity and FM capability of the generator are fully maintained.
Modular also means that you can purchase only the instrument or instruments you need right now. Then you can add others as your needs or budget dictate. Also, each instrument may be employed separately or to complement existing equipment, as you please.
Modular is better, too, because each instrument is autonomous and gives you better performance than if packed into a composite unit. Combined as a complete test set, the Metrix modular approach provides the best overall price/performance rating for comparable equipment on the market today. Here's what you get:

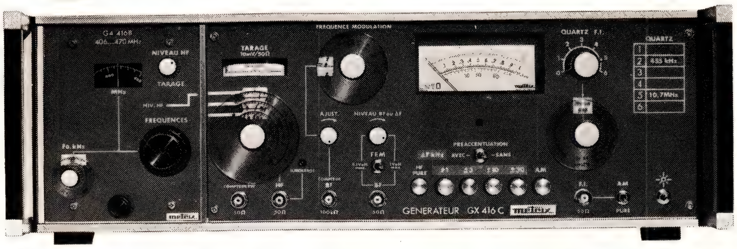
FX 456 B Frequency Counter – sensitivity 10 mV at 160 MHz, displays LF and HF frequency with resolutions of 1 Hz and 100 Hz, oven controlled oscillator gives accuracy better than 1 in 10^{-7}, stability 10^{-8} per °C and per day.



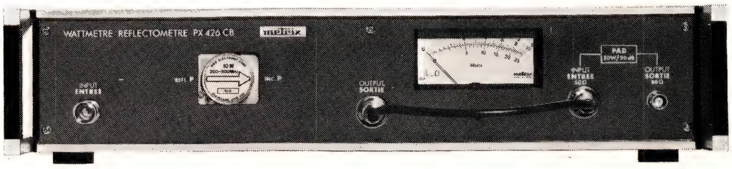
QX 436 B Modulation Meter – tuning by wide range AFC, measures frequency deviation, modulation depth, positive or negative peaks of demodulated signal, LF amplifier with inbuilt speaker.



GX 416 C AM/FM Signal Generator– continuous tuning, excellent spectral purity, all specialized bands from 25-470 MHz, 300 Hz-6 KHz LF generator, 6-channel quartz controlled IF generator for chosen frequencies 425-500 KHz and 10.5-13 MHz.



PX 426 C WSR Reflectometer/Watt meter
VSWR in 27-1000 MHz range, measures direct and reflected power up to 25 W, includes measuring inserts from Bird and Solabasic, internal power attenuator 20 dB 20 W (BNC connector).



Check the reader service card with the page number below. We'll see you get detailed information quickly.

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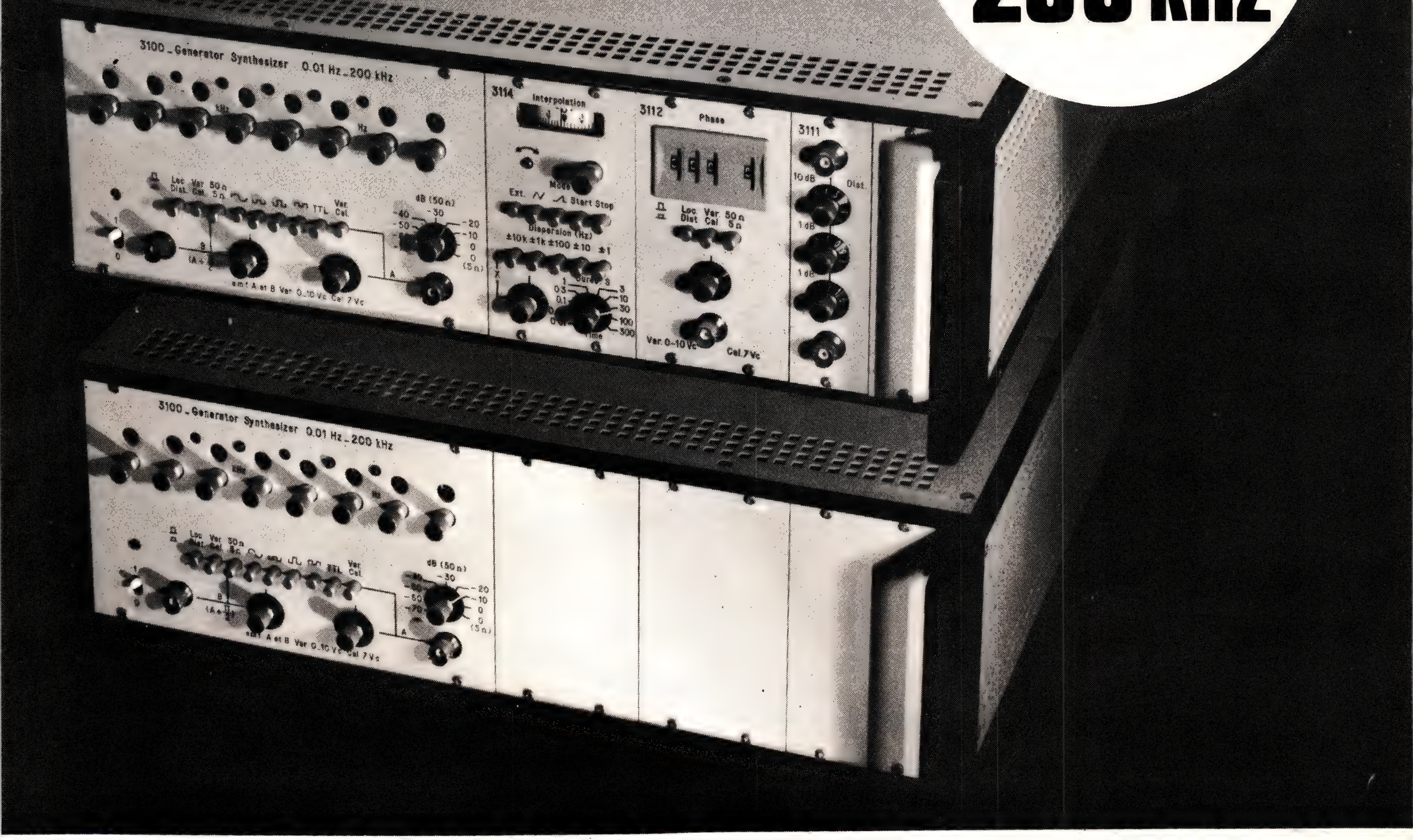
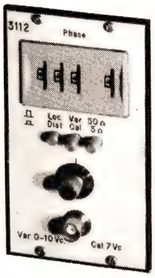

3100_Generator Synthesizer 0.01 Hz_200 kHz
3114
Interpolation
3112
Phase
3111
3100_Generator Synthesizer 0.01 Hz_200 kHz

The requirements of the many customers interested in a 200 kHz synthesizer being often quite different, Adret has developped this instrumental system able to suit the specific needs of each user.

The system consists of a mainframe receiving up to 3 options which provides both the output signals (sine and square waves) on its front panel and the signals necessary to the various options.



Phase standard 3112
(Local and remote control)
provides signals which are phase shifted from 0° to 359.9°, in 0.1° steps with respect to mainframe channel A.

Programmable attenuator 3111
provides up to 99.9 dB attenuation with 0.1 dB resolution to any signal generated by the 3100 mainframe or the 3112 phase standard.

Sweep/Search function 3114
provides search function and frequency sweep of the mainframe output signals. Free - running or triggered sweep can be achieved, both with markers for accurate frequency display.

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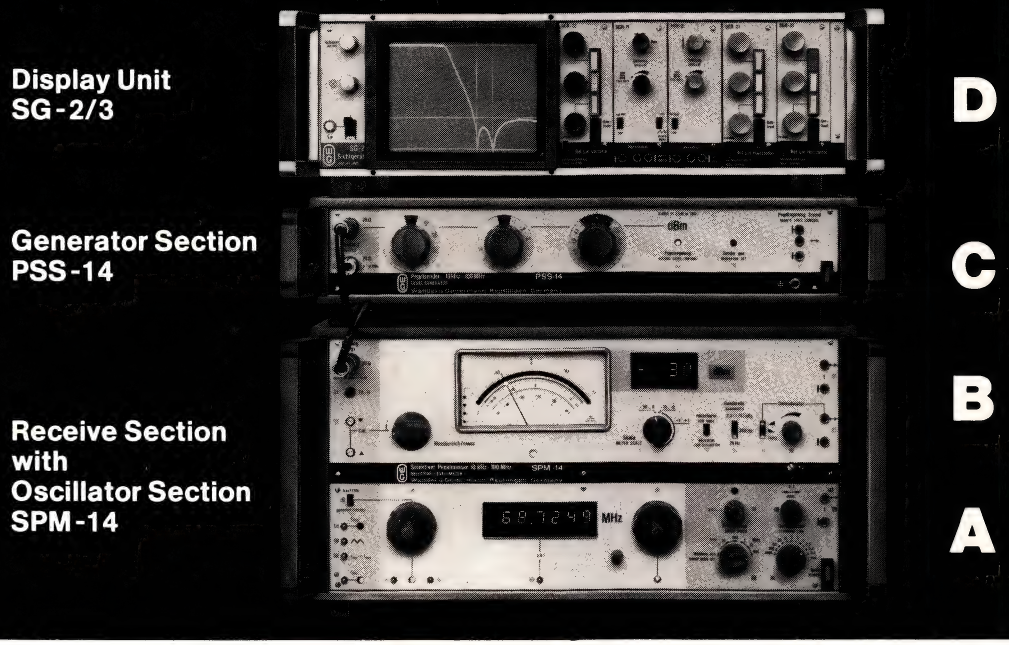
A new 10 kHz to 100 MHz Measuring System for Level and Sweep Measurements



The Most Economical Combination for Any Measuring Task:
A+B = Selective Level Meter SPM-14, A+C = Level Generator PS-14
A+B+C = Level Measuring Setup PSM-14
A+B+C+D = Sweep Measuring Setup WM-14

The Measuring System PSM-14/WM-14 has been designed to be a universal setup: for laboratories, test departments and maintenance, for in-service measurements on coaxial CF systems up to 10 800 channels, and in the 70 MHz IF band on microwave-radio-links.

The system's heart is **Selective Level Meter SPM-14** for carrier-, pilot- and noise-level measurements. Adding the Generator Section PSS-14 produces the **Level Measuring Setup PSM-14.** With that, the SPM-14 oscillator section synchronizes the PSS-14. Thus saving an oscillator and configuring this especially economical combination for laboratory and loop measurements. Distortion, translator and end-to-end measurements can be made with the SPM-14 just by adding on **Level Generator PS-14.** Display Unit SG-2 or SG-3 extends the PSM-14 to form the **Sweep Measuring Setup WM-14.**

- Great frequency accuracy through crystal locking
- Frequency readout through 7 digit counter, high resolution of 10 Hz
- Voltage and level linear receiver scale (20/100 dB)
- Built-in scale expander; ± 1 dB
- Level measuring capability > 130 dB
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Circle 244 on reader service card

Reduced support circuitry costs over the 8080A.

All Z80 devices require a single +5 volt power supply and a single-phase TTL clock. All control signals are directly compatible with I/O and memory devices so that system control circuits are not required. External interrupt control and prioritization circuits are unnecessary since these are included in each Z80 I/O circuit. DMA circuits are usually not required due to an extremely fast interrupt response and powerful I/O block transfer capability within the CPU.

That's just part of the story. Mostek's Z80 is backed by complete documentation, hardware/software support, field application engineers and immediate availability through your local distributor. For additional information visit your local distributor or contact the Mostek sales office in your area.

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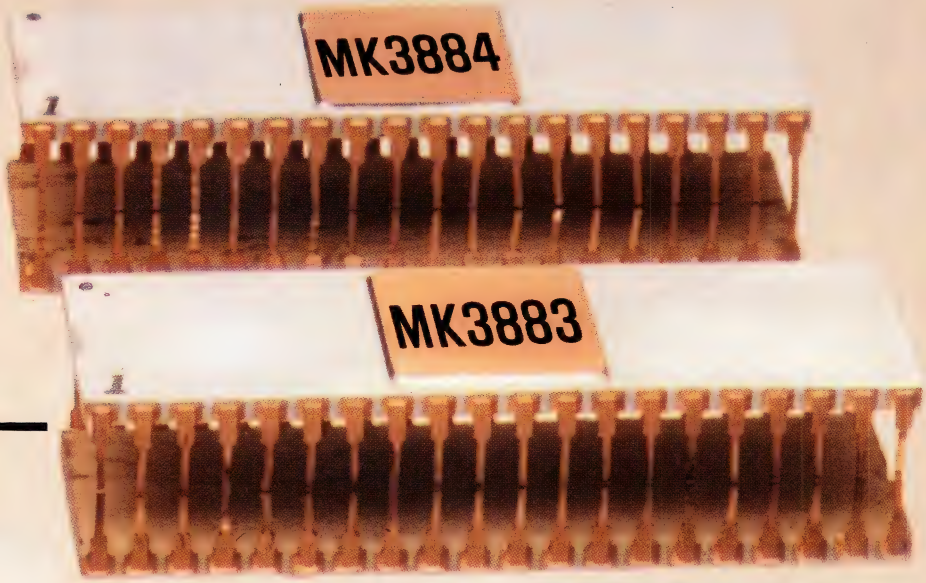
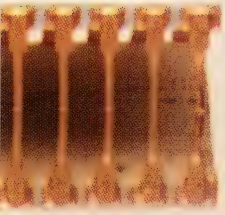
Serial Input/Output Controller (SIO)



Direct Memory Access Controller (DMA)



Circle 69 on reader service card

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the language is ppb

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MOS grade products: at an extremely sophisticated quality level, these fulfil the requirements of the latest MOS technologies.

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CARLO ERBA

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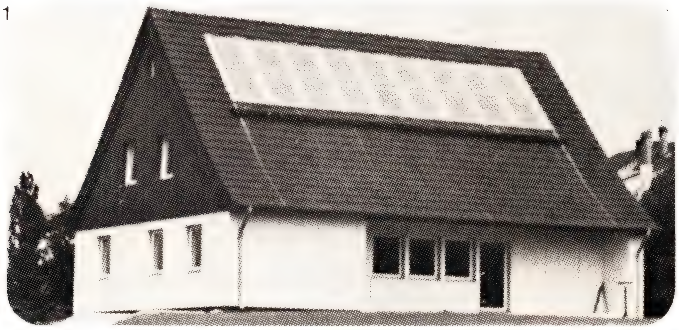
Telex Erba Mi 36314/Tel. 6995

MONTEDISON S.p.A. REG. TRADEMARK

Circle 246 on reader service card

prevailing in dry areas of many countries - and the 40 solar battery panels installed will deliver a total power of 400 watts. The development of the high-power solar energy source is a result of Philips extensive research into photosynthesis technology in general and the development of fuel and pollution-free energy sources in particular. Some other examples of how we have brought space-age technology down to earth are illustrated below.

1


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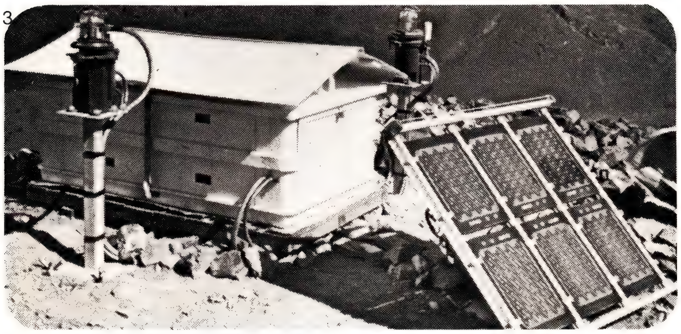

1 **To study methods of energy conservation** under practical conditions, Philips, in cooperation with the German Federal Ministry for Research and Technology and RWE, Essen, have built an experimental house on the grounds of Philips Research Laboratories in Aachen, West Germany. All household heating energy, totalling some 8300 kWh per year, is supplied by the sun; a Philips solar collector battery converting incident solar energy into low-temperature heat. In addition, soil heat is extracted via heat pumps, and heat exchangers recycle warmth from outgoing waste water and air. Energy consumption requirements of an average family are simulated by Philips computers which also control the heating system and process the data measured.

2 **Significant energy savings** are achieved when Philips SOX lamps are used for highway lighting schemes. Compared with any other form of road lighting, SOX lamps offer increased efficacy for less energy. For example, a SOX 135 W lamp can provide a lumen level of 21 500 lm. In more practical terms, SOX lamps can illuminate one mile (1.6 km) of a principal traffic route to modern standards with only 6 kW of electricity. Additional features of Philips SOX lamps include constant lumen output, excellent visual acuity, sharp contrast and reduced glare.

3 **Solar powered light beacon.** The airport of Medina, Saudi Arabia, is situated on a plateau in the mountains. And supplying electrical energy to illuminate the remote mountain peaks in the approach path would have been both extremely difficult and very costly. To overcome these problems, solar powered light beacons were mounted on seven of the peaks. In each case the equipment was transported by helicopter and installed in a matter of hours.

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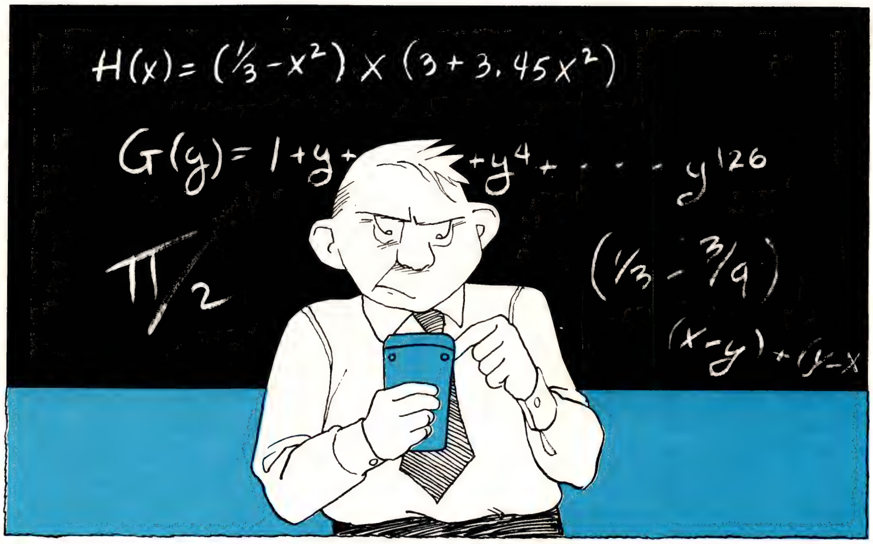
Can you count on your calculator?

Error analyst finds wrong answers turn up consistently in machines costing from $70 to $500

by Bernard Cole, San Francisco bureau manager



You can't trust your handheld calculator entirely, says William Kahan, professor of mathematics and computer science at the University of California at Berkeley and a specialist in error analysis as it relates to large computers and their software. In recent years, he has also applied his expertise to handheld calculators because he found that most of the so-called professional models "couldn't be trusted to do a few basic mathematical and engineering functions accurately."

For simple arithmetic functions, those encountered in day-to-day accounting and checkbook calculations, almost any machine—from the $5-to-$10 "cheapie" to the $400-to-$500 high-end programables—can perform adequately. But for the more complex mathematical, engineering, scientific, and financial functions—the ones the so-called high-end professional calculators were designed to handle—the situation is laughable, says Kahan.

Widely available sophisticated calculators produce surprisingly wrong answers, he says, surprisingly often in the process of performing such basic calculations as:

- Elementary transcendental functions, such as sine, log, and so on.
- Means and standard deviations.
- Solutions of two linear equations with two unknowns.
- Solutions of quadratic equations.

Even in an operation as simple as calculating numbers carried to various powers, most sophisticated machines, from the $70-to-$100 nonprogramables (such as National Semiconductor Corp.'s Mathematician PR) to the $400-to-$500 machines (such as the SR-51 and 52 from Texas Instruments) are inaccurate, says Kahan. For example, 2^3 is 7.999994 on a middle-range professional machine (National Mathematician PR), and 8.00000002 on others. One high-end 13-digit machine displays 8.000000000 as the answer. But when the number is subtracted from itself, three nonzero numbers appear—the other three "hidden" digits.

Such errors, say many calculator makers, are trivial and are eliminated by simple rounding or chopping off. Kahan agrees that in and of itself such a simple calculation error is trivial. "But the important thing to note is that engineers seldom calculate the power of a number for that alone," he says. "In most cases that function is just part of a larger mathematical formula. What's worse, the calculations usually involve large numbers of repetitions."

In more complex calculations of, say, means and standard deviations, the errors are more grievous and less predictable. The standard deviation of 10 numbers starting with 9,999,999,990, from a mean value of 9,999,999,999.5, is 3.02765034. But on the Hewlett-Packard machine he tested, Kahan says, the standard deviation displayed is 105,409.2553. On others, (such as the SR-51), the answer displayed is 0.

Bent slope. The microcoded algorithms that lead to such errors in standard-deviation calculations also mess up other more practical calculations in which the standard deviation is used, such as finding the slope and constant for the best straight line fit through colinear points. "For 1- or 2-digit numbers, sometimes even 3- or 4-, most high-end calculators can perform this calculation with no trouble at all," says Kahan. But in many of those cases, the solution is so obvious it is unnecessary to use a calculator at all. In this example, finding the equation of a line fitting three colinear points: 665,999 and −1;

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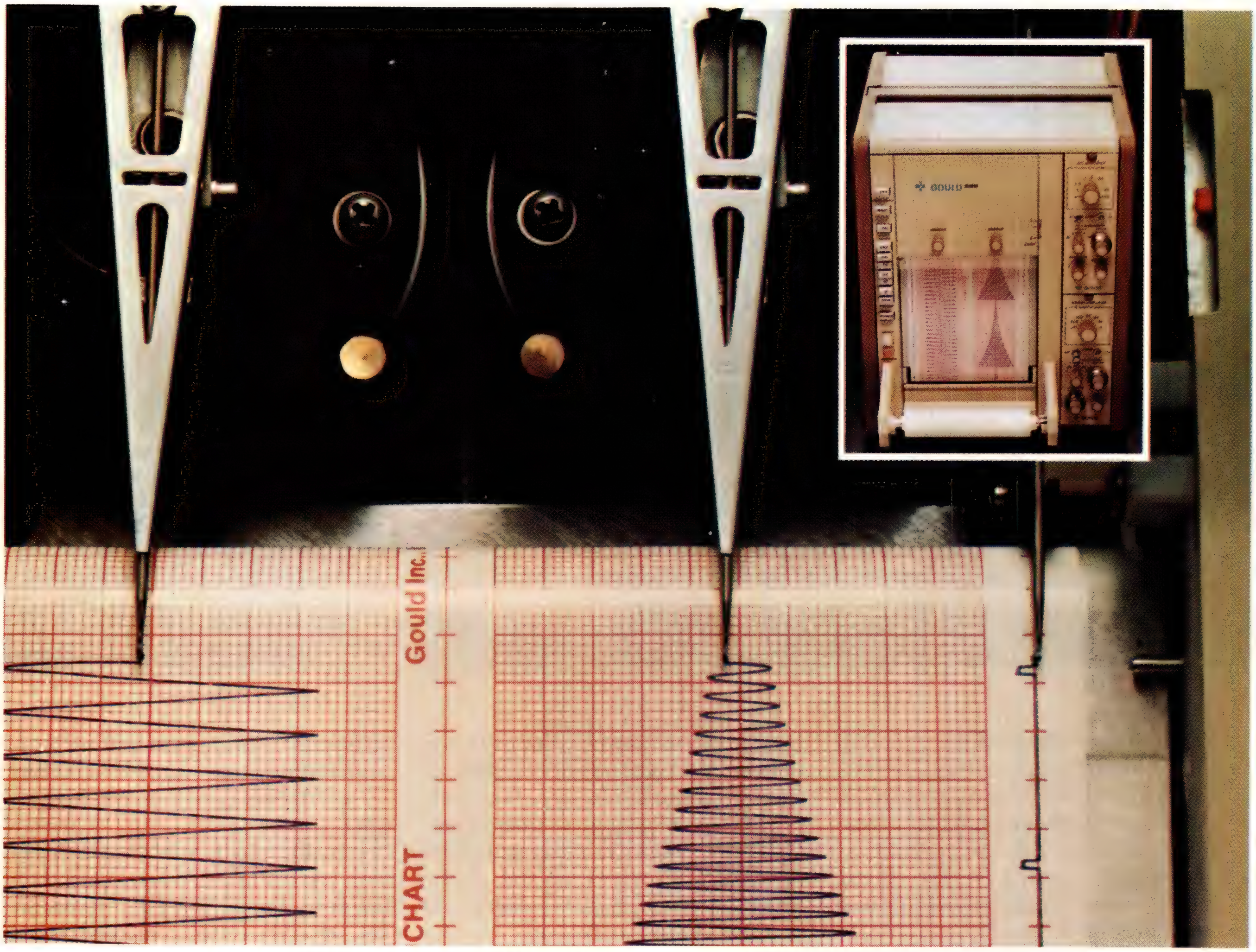

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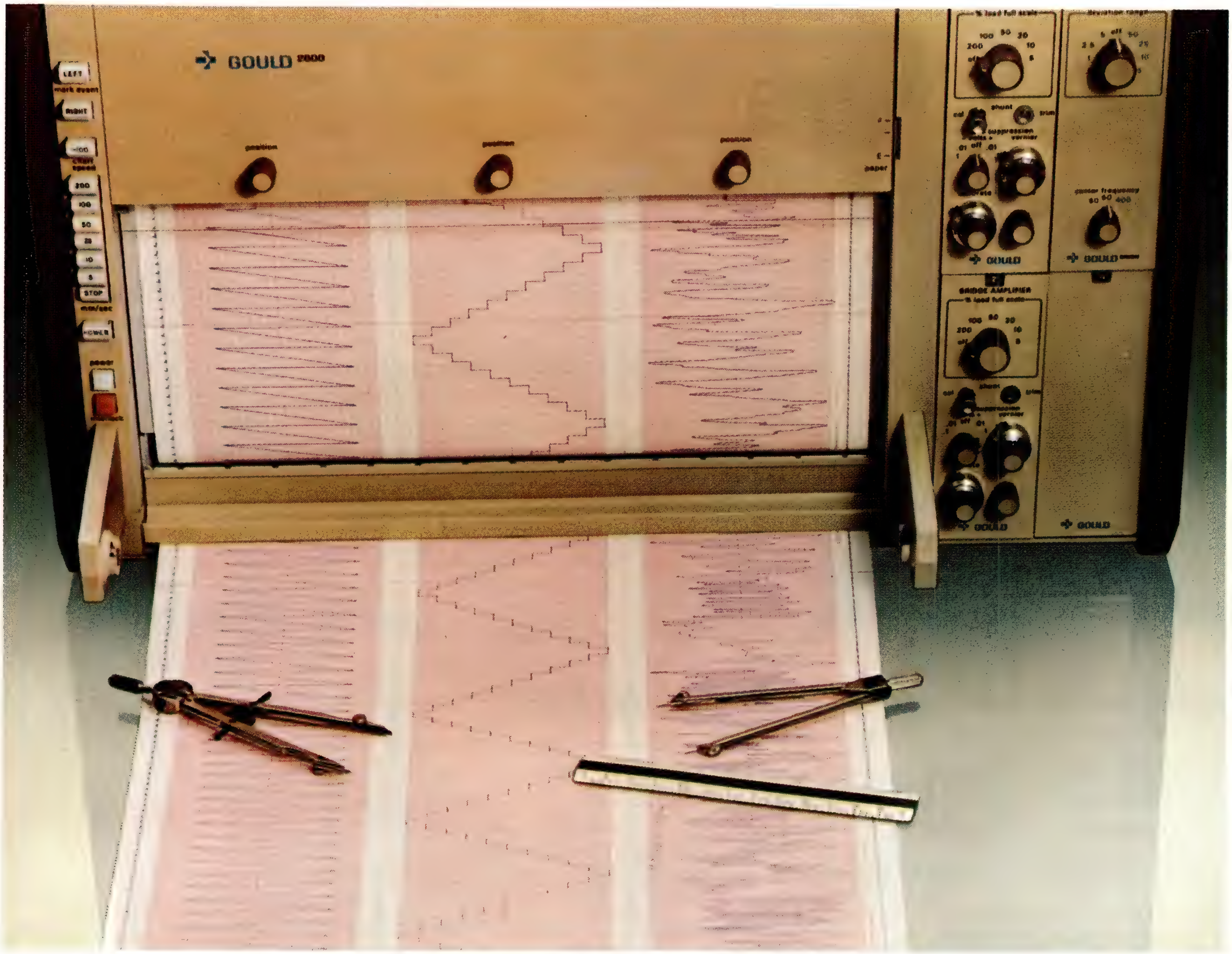

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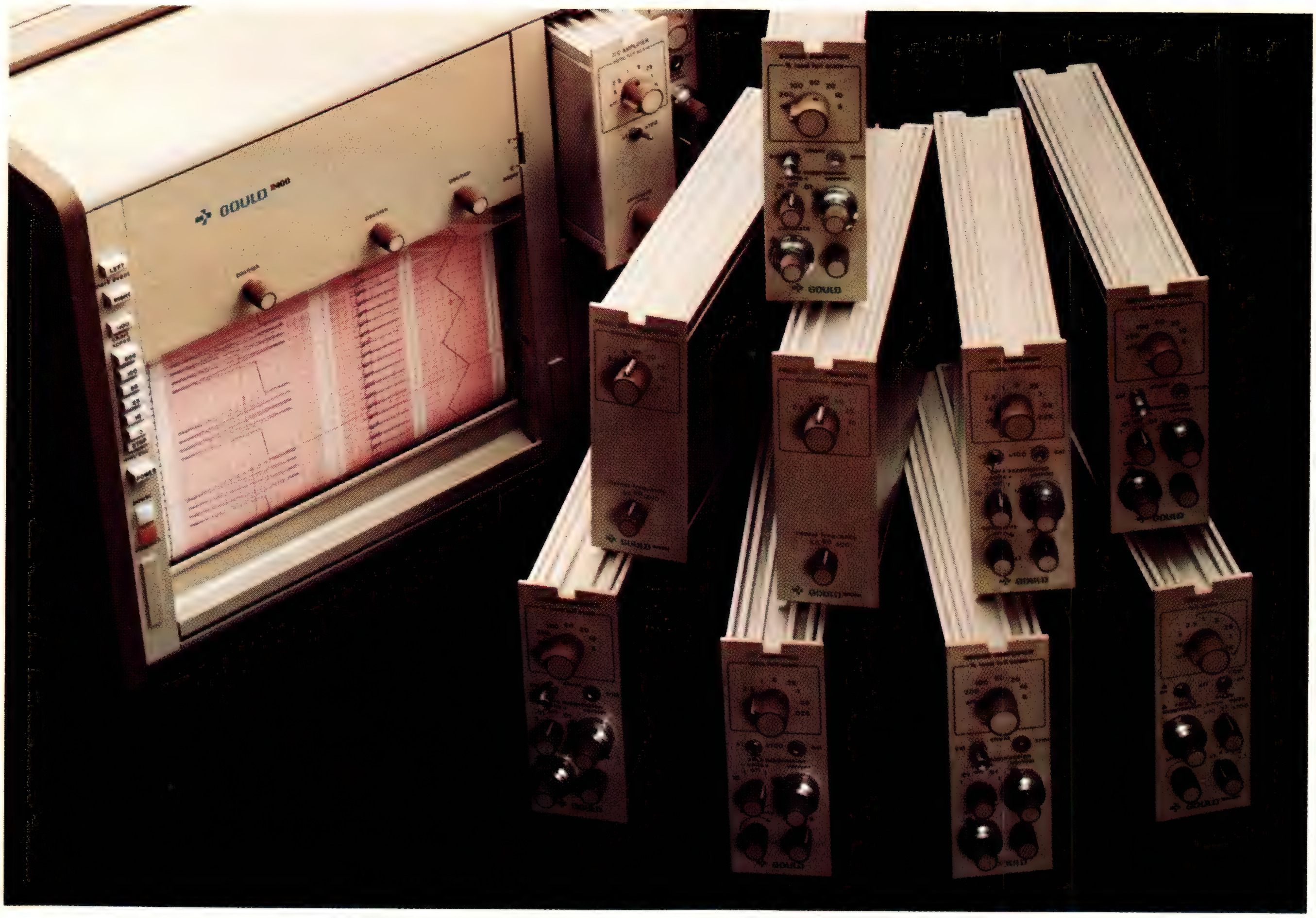

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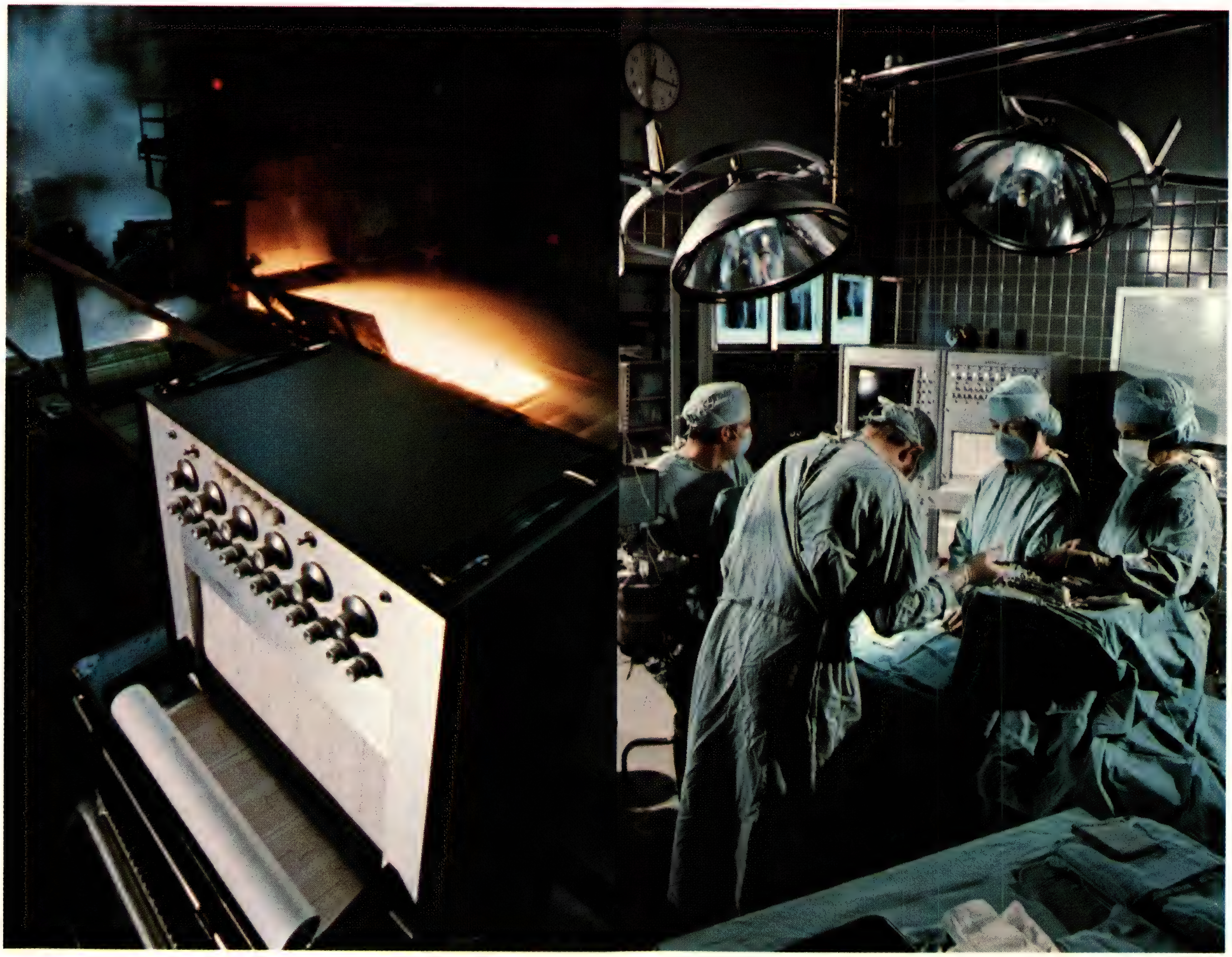

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Electronics abroad

Color-TV sales boom in Spain

Sets provide bright spot as political unrest and 20% inflation will combine to make 1977 a flat year for electronics industries

by William F. Arnold, London bureau manager

For electronics suppliers, the gain in Spain lies mainly in the consumer sector. Spanish consumer executives, saying they were caught by surprise this year when sales of color-TV sets took off, expect the continuing boom to buoy consumer electronics.

But that's about the only sunshine in otherwise cloudy skies, say executives in other electronics sectors. "The best we hope for next year is 0% real growth," confides one data-processing-equipment manufacturer, a refrain expressed by other executives to *Electronics.*

Spain is holding its breath as it moves uncertainly to a more democratic form of government. Spending by the government for new programs is stalling, investment money is drying up, and businesses are tending to put off purchasing new equipment. Consequently the economy is going unattended, and the inflation rate is shooting up to 20% or more.

Overall, however, inflation and inertia combine to give the Spanish electronics market a slightly brighter hue than that which some observers see, according to initial estimates.

Electronics forecasts the total Spanish electronics market next year at $1.1 billion, up 13.6% over 1976. All sectors show increases, with consumer products leading the way in terms of real, or noninflated, growth. Computers and communications, the next two biggest sectors, also show reasonable growth considering the uncertain times. *Electronics*' estimates of local consumption (68 pesetas to the dollar) are based on factory prices, not retail.

Component and TV-set suppliers expect next year's sales of color sets to soar to 300,000 to 400,000 sets, up from about 200,000 units this year. Black-and-white sales will fall to nearly the color level.

Color-TV sales are expected to rise to $176 million in 1977, up substantially from the $132 million this year. That will be almost half of the total estimated consumer market of $394 million next year, up from this year's $338 million. All in all, the boom should continue, says Rafael Salvador, marketing vice president for Piher, a leading components maker.

The sagging economy has reined in Spain's telephone company, the Compania Nacional Telefonica de España. Orders for telephone exchanges are down this year, and next year doesn't look much better, says José Coronado, assistant to the president of ITT subsidiary Standard Electrica, S.A., Madrid. *Electronics*' estimates show some increase in orders for public switching to $23.5 million from $19.1 million.

In sum, the communications sector will show a modest increase next year to $256 million, with the microwave relay section rising to $30.2 million and telephone and telegraph carrier equipment rising to $89.7 million.

Computers and related equipment will slow their surging growth as the downturn hits this category, too. Projected sales are $297 million, up from $255 million this year. Minicomputers will jump to $15.3 million; data terminals, which should reach $13.2 million; data storage at $45.6 million, and office equipment at $53.7 million.

The microprocessor and minicomputer market could well explode as many small companies automate their accounting to help beat inflation, according to Carlos Mendez, marketing development and research manager at Sperry Univac.

Pocket calculators may suffer but desk calculators may be a little bit better says Luis Calvo, sales director, Instruments and Components division, Hewlett-Packard Española, Madrid. In planning a 10% increase in real terms for next year, HP may lead the general test and measuring category. ☐

SPANISH ELECTRONICS MARKETS FORECAST (IN MILLIONS OF DOLLARS)

	1975	1976	1977
Total assembled equipment	822	1,007	1,129
Consumer electronics	265	338	394
Communications equipment	203	228	256
Computers and related hardware	227	255	297
Industrial electronics	54	69	80
Medical electronics	39	44	51
Test and measuring equipment	28	32	39
Power supplies	6	7	8

Spanish look. Consensus estimates of consumption based on *Electronics*' survey in October and November. Domestic hardware is valued at factor prices, imports at landed costs.

This is the first in a series examining European markets.

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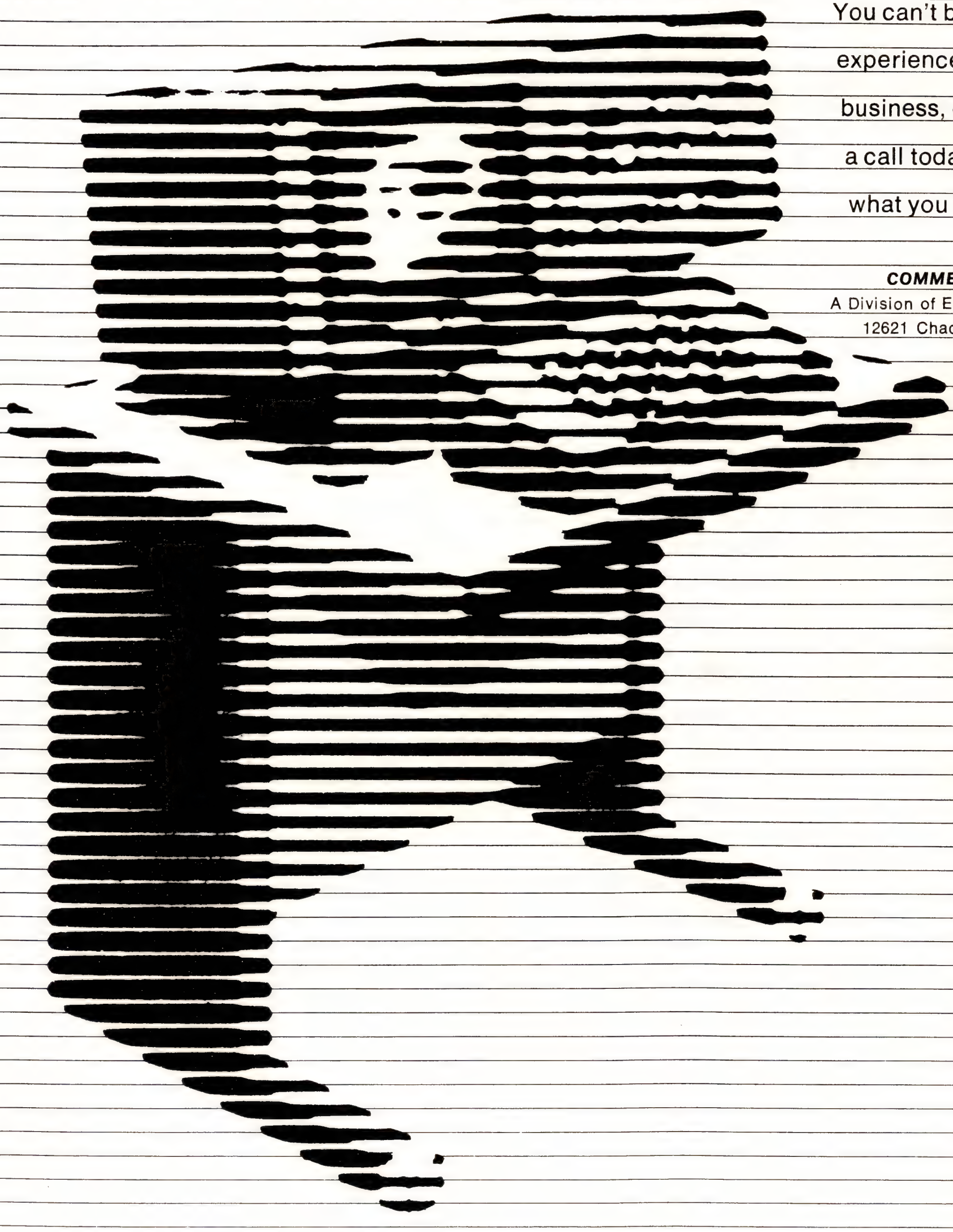

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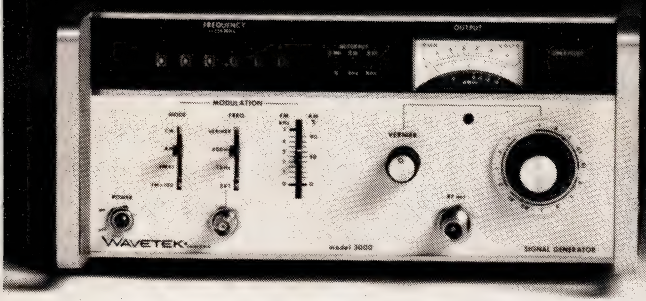
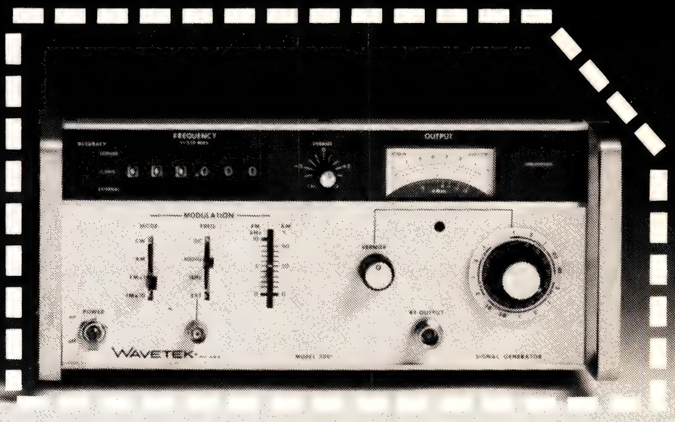


The Model 3000.



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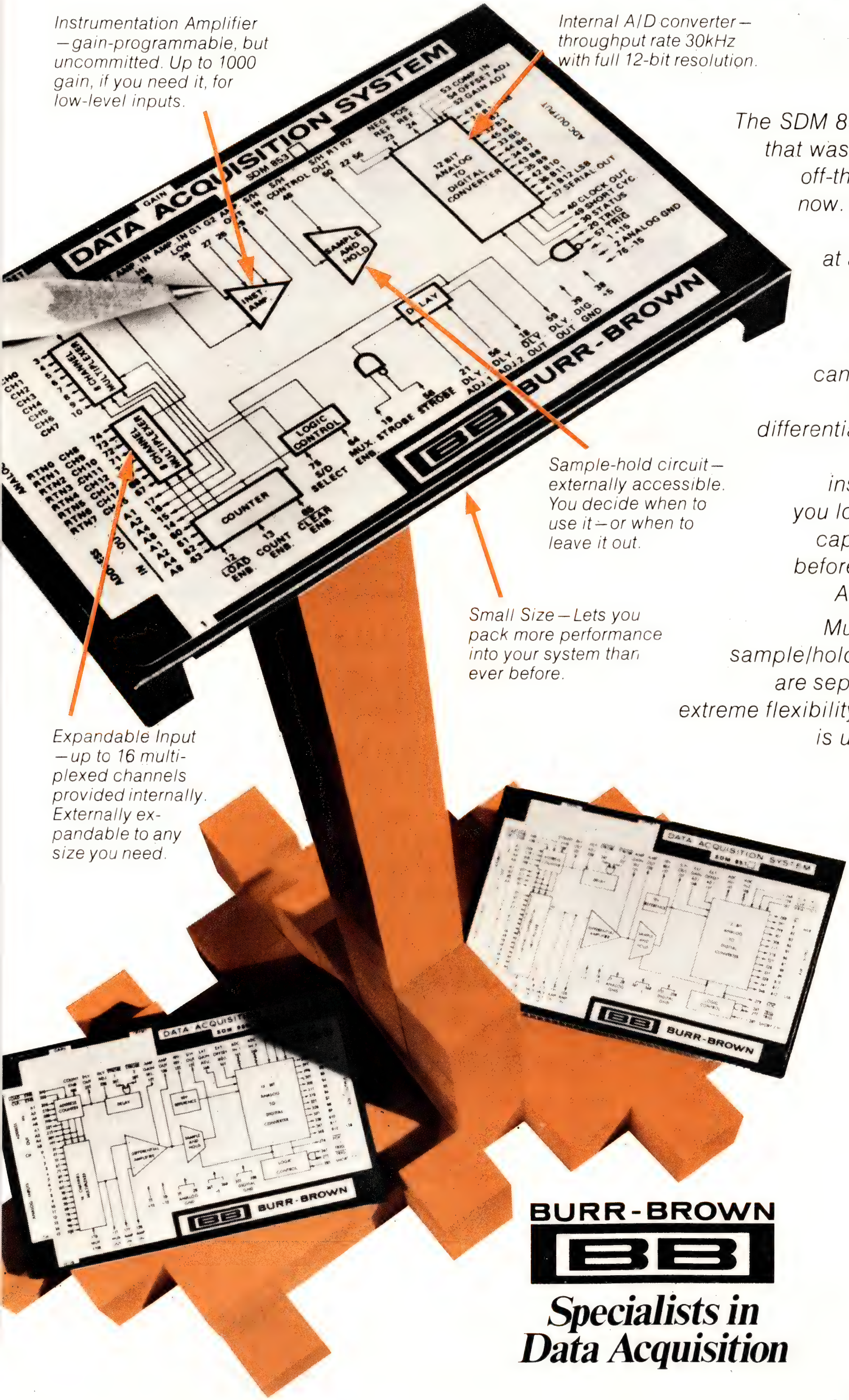

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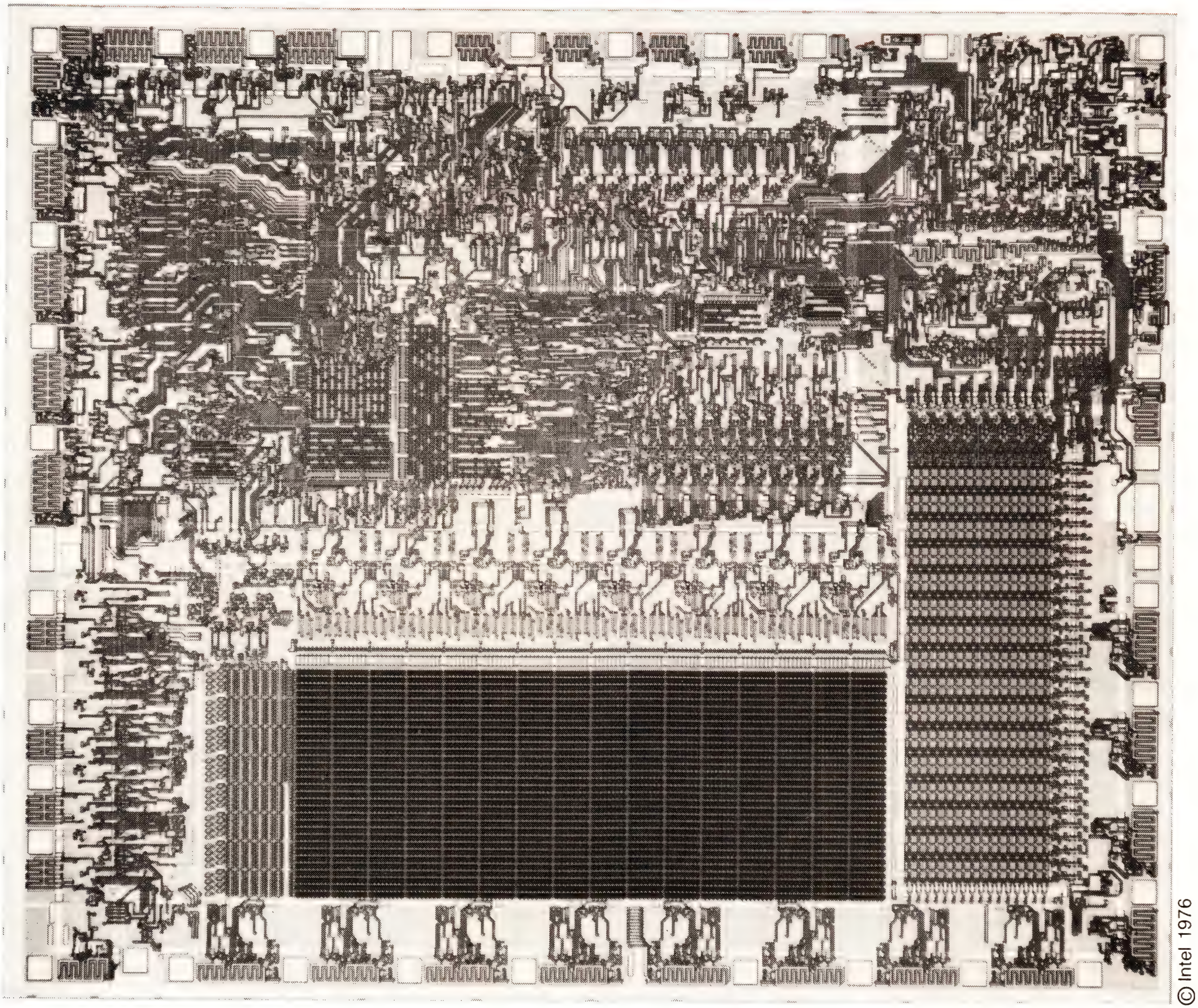

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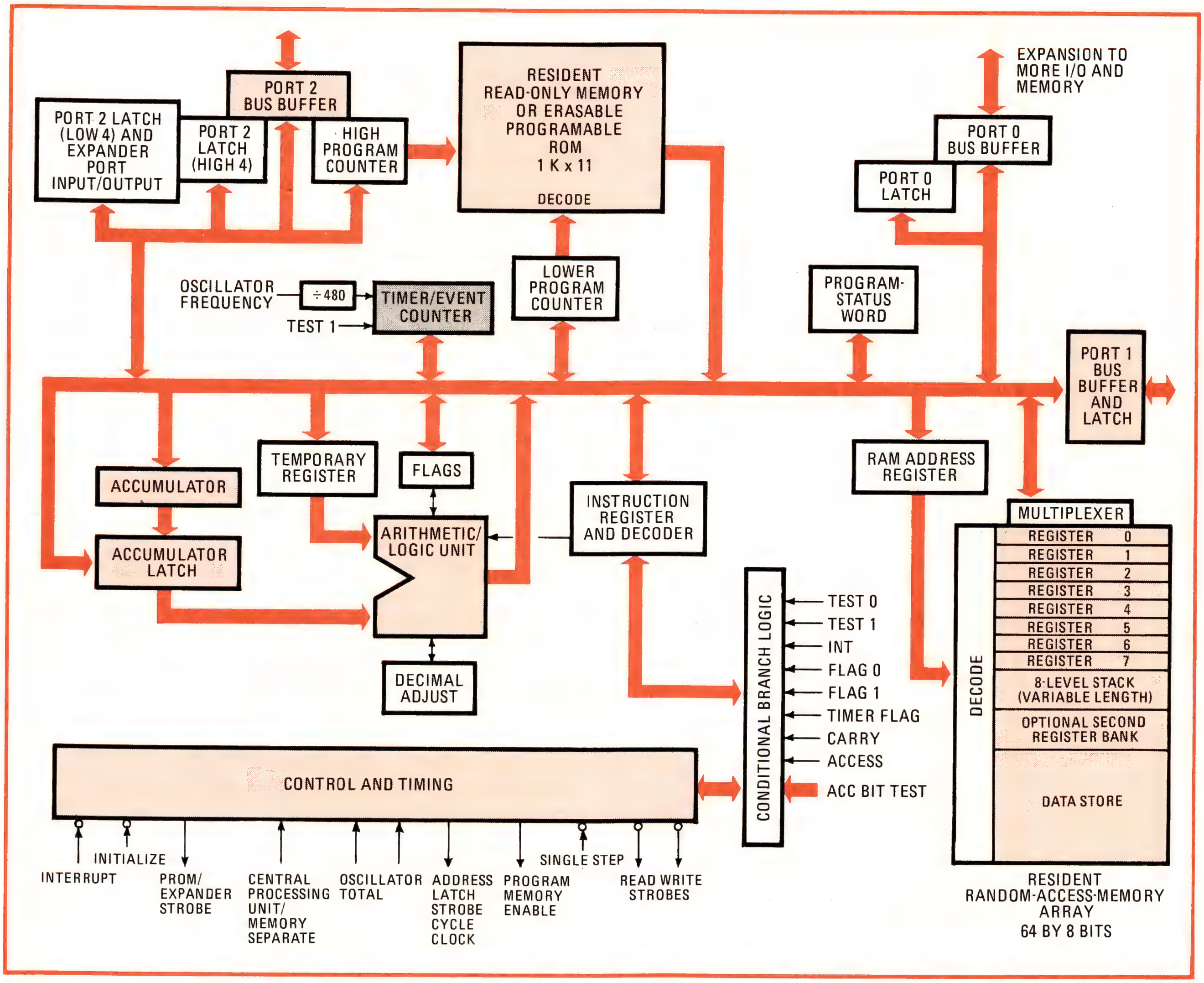
Single-chip 8-bit microcomputer fills gap between calculator types and powerful multichip processors

Capabilities range from stand-alone computing to high-power data processing; ultraviolet light erases programable ROM of one version

by Henry Blume, David Budde, Howard Raphael, and David Stamm,
Intel Corp., Santa Clara, Calif.



2. Stacked. The 8748 or 8048 processor chip supplies all the functions needed for a stand-alone microcomputer. It has a CPU complete with arithmetic/logic unit and accumulator, a 256-bit RAM, an 8,192-bit program ROM, a timer/event counter, and plenty of I/O capability.

the 8080 family of standard memory and peripheral parts, soon to number about 30 large-scale-integrated circuits. They include timers, programable I/O controllers, universal synchronous/asynchronous receiver/transmitters, decoders, and keyboard/display controllers.

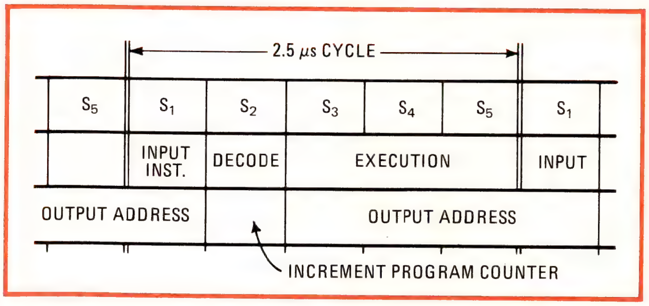
One-chip advantages

The integration of all the basic blocks of a microcomputer system into one circuit brings about some architectural advantages. When the device is used as a stand-alone controller, it need interface only with its I/O peripherals. This means that the execution speed of the processing is limited only by the speed of the chip, because there is no slowdown from transferring data between memory and CPU, as in multiple-chip designs.

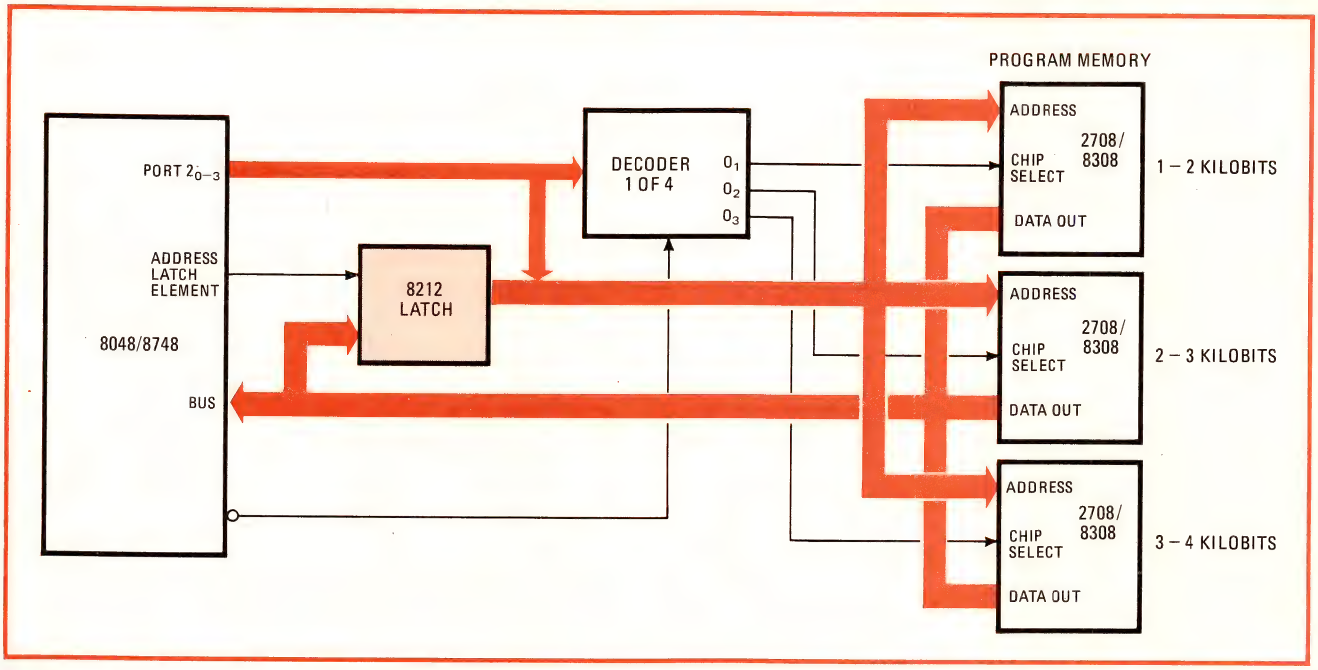
Moreover, technological upgrades can give enhanced performance without waiting for similar upgrades of external components, as is usually the case with multi-chip families. More immediately, the inclusion of data and program memories, which otherwise would have to be added separately to the system, simplifies the user's interface problems.

Having an active data store on the chip—the quasi-static 64-by-8-bit RAM—also simplifies system implementation, since all scratchpad operations simply became part of the CPU function. There is no need for refresh circuits operate the RAM; yet the device is dynamic in the sense that internal clocks are used for very fast, low-power access to the array.

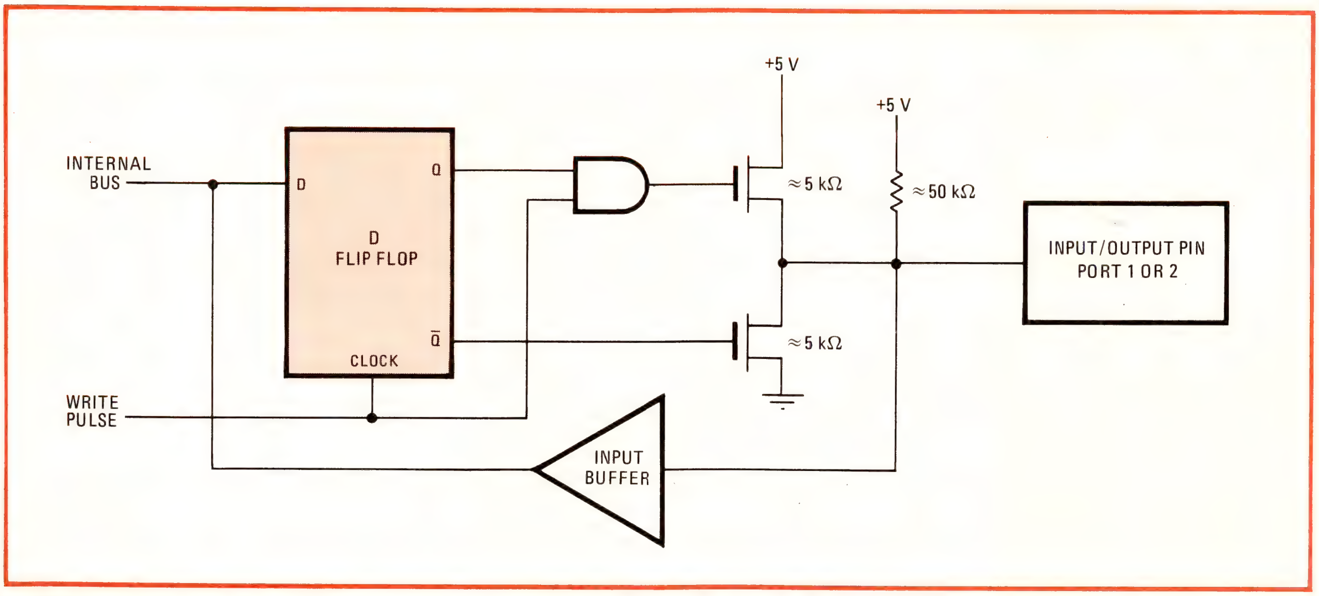
The major objective was access to a RAM within a



3. Simple. Operating the 8748/8048 is extremely straightforward, with each 2.5-μs cycle consisting of five states. Instruction inputs are made in state 1, decoding and program incrementing in state 2. Program executions begin in state 3 and run through 4 and 5.



5. Latching on. Adding standard memories to the system is quickly done with external latch 8212, which allows standard memory parts to be hooked directly onto the 8748/8048 bus. Operation of the latch is under the control of signals from the processor.



6. Mixing it up. Besides the main system port, 0, the processor chip has two others, 1 and 2, which allow inputs and outputs to be mixed on the same port. Here, writing a 0 causes the pull-down devices to sink the TTL load; writing a 1 calls on the 50-kilohm pull-up resistor.

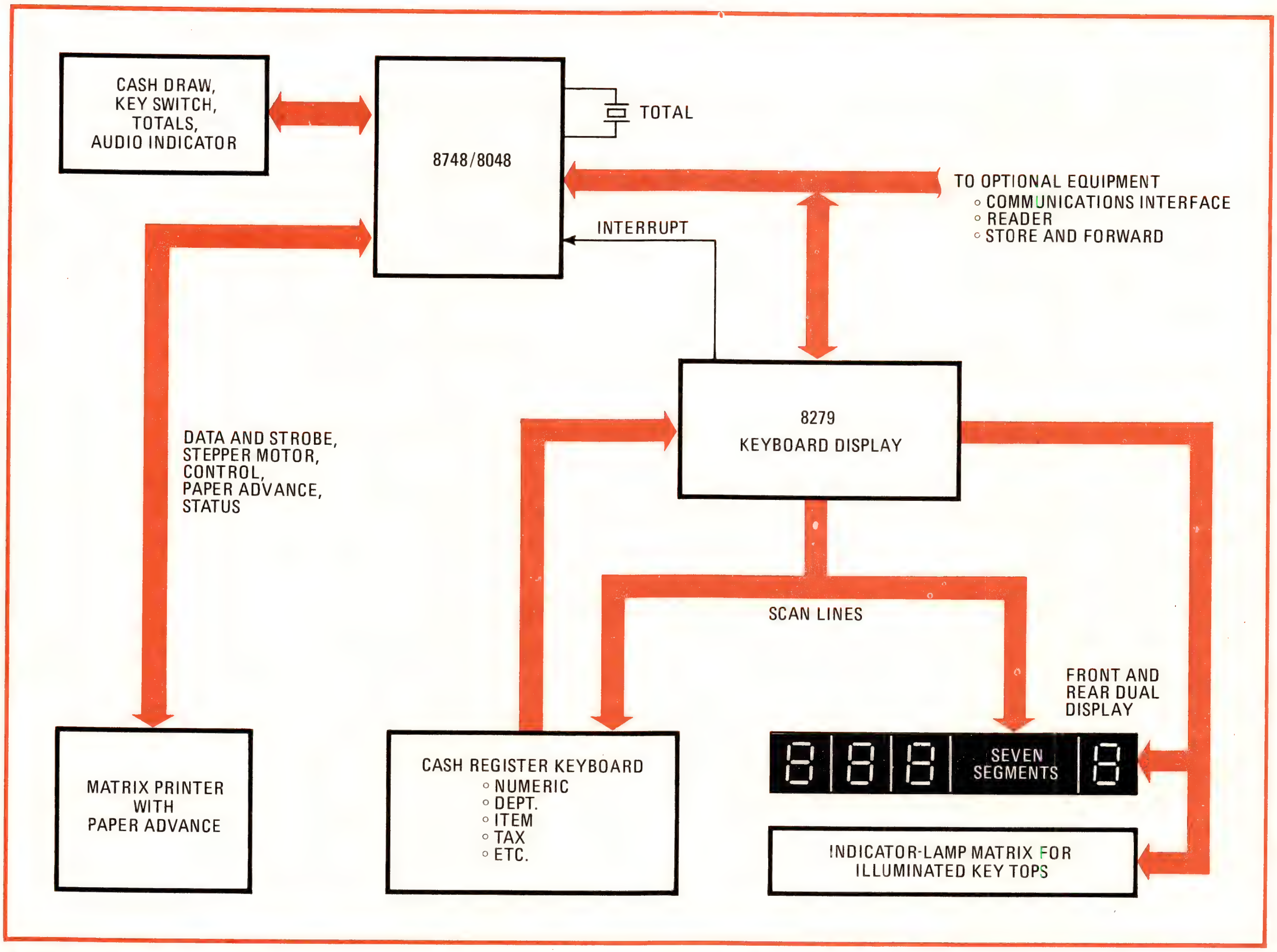
reference is finished with the address.

One key to the simple operation of the 8748/8048 chip is the straightforward program sequences and timing needed for executing an instruction cycle (Fig. 3). Each cycle consists of five states. Instruction input is made in state 1, and decoding and pc incrementing is made in state 2. State 3 starts the beginning of the program execution, which can run through states 4 and 5. Simultaneously, the next cycle's program address is made in state 3, a pipelining (paralleling) of operations that increases device throughput significantly.

Because the chip is built with depletion-load silicon-gate n-channel technology, it operates off a single 5-volt supply with inputs and outputs that are compatible with both transistor-transistor-logic and complementary metal-oxide-semiconductor devices. Instruction cycle time is a modest 2.5 microseconds and power consumption is a low 400 mW. Depletion-load techniques also pay off in practical chip sizes for volume production; the 8048 also is slightly over 200 mils on a side, while the 8748, with its big 8-k EPROM, is 221 by 261 mils.

Storing data in the scratchpad is simple, because part of the RAM can be reserved for one or two banks of 8-bit working registers—eight registers per bank (Fig. 4). The scratchpad also contains the subroutine address stack, which can be eight levels deep. Each location can accommodate the 12-bit pc and 4-bit status data.

Since all locations in the stack are indirectly address-



8. Working together. Proof of the MSC-48's ability to handle large systems is this gas-pump controller. The 8243 I/O expander chips allow the processor to interface with 47 lines and a USART communicating with a central control unit inside the service station.

tions. Here, the ALU generates a carry output fully accessible to the programer under program control.

The timer/event counter is an 8-bit register that can operate in one of two modes, selectable under software control. As a timer, the device measures elapsed time. It is fed by the crystal frequency, divided by 280. At maximum frequency, the result is about 80 μs per increment, or about 20 milliseconds over the counter range. As an event counter, a test line is designated to count 0 to 1 transitions of external events. As many as 256 transitions may be accommodated.

Both the timer and the counter indicate overflow by a maskable internal interrupt or by a testable flag bit. The internal interrupt may also be used to provide the system with a second external interrupt.

The input/output facilities of the 8048/8748 have been designed for maximum flexibility and expansion and are fully TTL-compatible. The basic facilities consist of three 8-bit I/O ports plus three test/interrupt inputs.

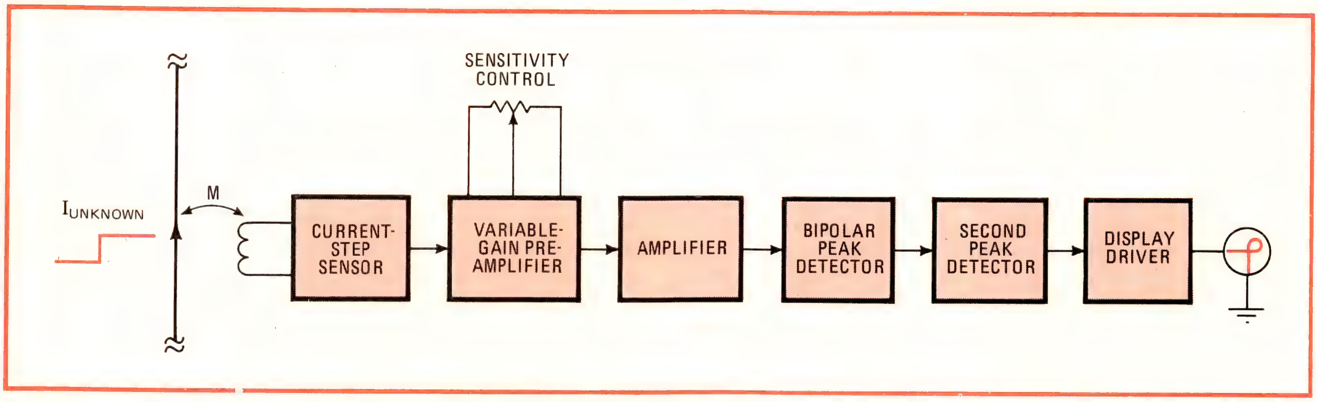
Port 0, called the bus, provides for system expansion. In essence, the port makes the bus completely compatible with an 8080 bus, so that all 8080 peripherals can be used with the MCS-48 family. In conjunction with four control and strobe lines, the port may be used for bidirectional interfacing to memories and I/O elements. For free-standing operations, it may be statically latched or used as a general input port.

The remaining two I/O ports, 1 and 2, are termed "quasi-bidirectional" (Fig. 6). They allow inputs and outputs to be mixed on the same port. When writing a 0 (low value) to these ports, the pull-down device sinks the TTL load. When writing a 1, a large current is supplied through both pull-up devices to allow a fast transition. After a short time, they shut off and the pull-up of the 50-kilohm resistor sustains the 1 level.

Applying the 8748/8048

Two applications show the range of complexity that can be accommodated with this family. Figure 7 shows a typical minimum-chip MCS-48 system, in this case, a drum printer controller. The three output ports allow the one-chip 8048 to control the printer position, ribbon shift, and line feed. Two interface drivers operate the solenoids.

Figure 8 shows a far more complex system, in which the MCS-48 implements a low-cost point-of-sale terminal. The I/O capability of the 8748/8048 chip can be expanded to control and monitor many cash-register operations. These might include cash in the drawer, key switch, totals, audio indicator, as well as matrix printer, cash-register keyboard, seven-segment display, and a variety of optional equipment. □



2. Gain stages. The voltage induced from an unknown current spike as small as 1 milliampere requires multiple stages within the tracer to be amplified and stretched enough to drive an incandescent lamp to visible levels.

pickup coupled to a time-domain filter that rejects unwanted signals. This method can be quite effective, but requires a cable to synchronize the pulser with the pickup. This, along with the size of the instrument needed to perform the task, makes this system also somewhat awkward to use.

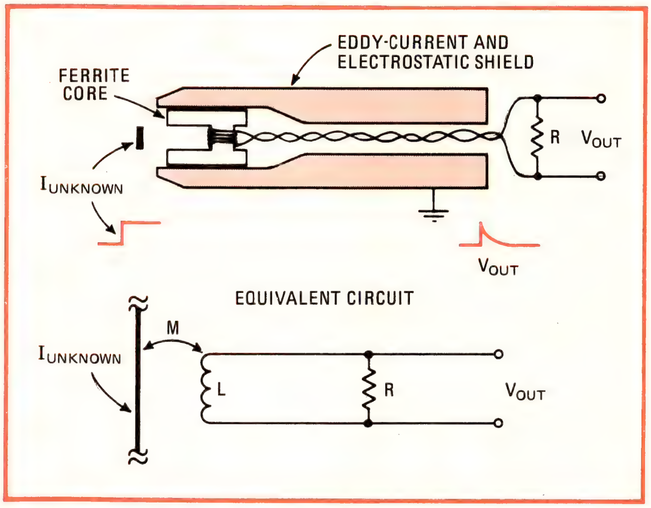
Simplifying the task

The HP current tracer is more compact than synchronized-signal tracers and is simpler to use. Since its dynamic range is large enough to respond to current changes present in most digital circuits, it typically does not require a stimulating signal. If a stimulus is required, as when testing an unpowered system, a signal can be provided by a logic pulser such as the HP 546A, or other models from HP and other logic-tester manufacturers. Even then, the tracer's shielding eliminates pickup from adjacent signal paths, so no synchronizing signal is needed.

The current tracer's tip is first placed near the driving point of the node, which is usually one of the IC terminals or the tip of the logic pulser. The tracer's sensitivity-control thumbwheel, which provides a range from 1 milliampere to 1 ampere, is adjusted until the display lamp is between half and fully lit. The thumbwheel is designed so that its position yields some indication of the magnitude of the current flowing, which may be useful in determining the nature of the fault. For example, if it indicates an abnormally high current, the fault is due to a low impedance on the node.

The tip of the tracer is then moved along the conducting path, and the display remains at the same brightness as long as the same current is present. If the current is diverted to another path, then the increased separation between the tip and the current lowers the output of the current-step sensor, and the display becomes less bright. The operator gets enough information to track the actual path followed by the current as it flows toward the fault.

Since the current tracer is picking up current pulses by inductive coupling, its tip need not make physical contact with the conductive path. Thus, insulated wires and inner traces of multilayer pc boards can be tested.



3. Current converter. Fine wires wrapped around a ferrite core act as a current transformer loaded by a small resistance that produces an output voltage. A conductive shield protects against unwanted magnetic and electrostatic fields.

The current tracer contains six stages of signal processing and amplifying circuitry within its cigar-size case (Fig. 2). A step change in current at the tracer's tip is coupled, via mutual inductance, to the current-step sensor. This produces a voltage spike proportional in amplitude to the current step.

The spike is fed to a variable-gain preamplifier, which produces an output of about 1 millivolt when the sensitivity control is properly adjusted. This signal is further amplified, then stretched in time by two peak detectors in order to produce a pulse of sufficient height and width to light the incandescent lamp that serves as the tracer's display.

The current-step sensor (Fig. 3) operates like a current transformer. It provides information about current changes, not a quantitative display of the total value of the current, but this is sufficient for faultfinding in digital systems.

A step change in current near the tip of the tracer attempts to induce an emf in the windings on the coil within the sensor. But, because the coil is nearly shorted by a low-value resistor, a current is induced in the coil large enough to cancel the flux change caused by the unknown current step. The current step induced in the pickup coil has a magnitude that is proportional to that of the unknown current.

The induced current flows through the resistor, energy content of the pulse that flashes the display can be greater than 10^{14} times that of the energy captured by the sensor.

With the shielding of the sensor, with the orientation of the amplifier components, and with careful pc board design, it is possible to electrically decouple the input from the output. In fact, the current pulse that drives the display lamp actually passes right through the amplifier area of the pc board.

Running the supply and return traces on the inner layers of the multilayer board, one above the other and separated by a very thin insulating layer, and covering them with an outer-layer ground plane confines the fields from the display pulse to a very small space. The ground plane also was designed so that the charging currents of the parasitic capacitance between the grounded eddy-current shield and the trace under investigation can pass through the amplifier area of the board without inductive coupling of unwanted signals.

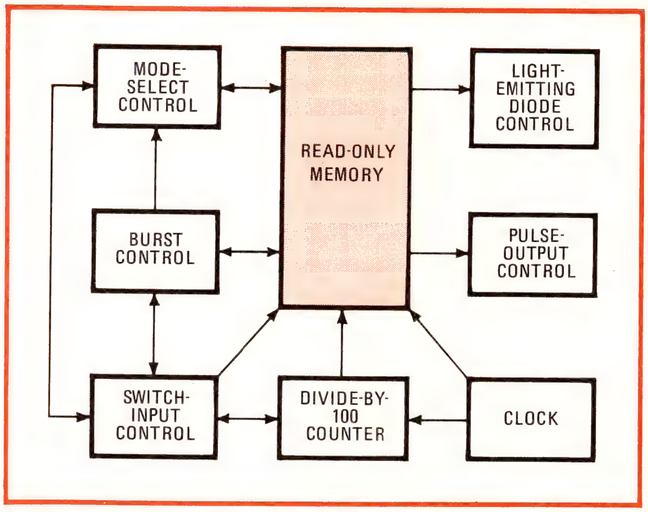
Resolving problems

This still does not solve all the problems of designing a wideband, high-gain amplifier for the tracer. It is necessary to bring the fault currents in the various logic families and pulse stimulators to a common reference level so that the operator sees only the value of the current at the tracer's tip relative to that at the driving point of the node. The 60-dB (1,000:1) gain variation demanded by currents from 1 mA to 1A cannot be achieved with a potentiometric divider, since the parasitic inductances and capacitances at the extreme positions of the divider destroy the required high-frequency response. It is also necessary to insert the gain control at the initial stages of the amplifier chain because the requirement for operation from 5-V supplies severely restricts the linear operating range of the amplifiers.

To solve these problems, the entire 60 dB of gain control was placed in the first amplifier stage. The basic configuration of the stage is a single transistor with an emitter resistor that is approximately equal to the collector resistor and has no bypass capacitor. Current-controlled variable resistances, in the form of Schottky and silicon diodes, are ac-coupled to the collector and emitter resistors. When the sensitivity control on the tracer is in the 1-mA position, the emitter resistance is low and the collector resistance is high, forming a common-emitter amplifier of 20 dB gain. When the sensitivity control is in the 1-A position, the collector resistance becomes very small and the emitter resistance large, so the circuit becomes a 40-dB attenuator.

Stretching pulses

When the sensitivity control is set so that the display is at its reference level, the output of the current-step sensor emerges from the amplifier chain with an amplitude of about 500 mV and a width still of about 150 ns. The polarity of this output may be positive or negative, depending on the polarity of the current step and the randomly chosen orientation between the current path and the pickup coil in the tracer. Since the operator is interested only in the variation of this pulse as the tracer tip is moved from place to place, all that is required is a display-driving signal proportional to the amplitude of the output of the amplifier chain, but independent of its polarity and long enough to be visible.



4. Pulse control. Almost all the circuitry of a logic pulser is contained on a custom integrated circuit, including the read-only memory that controls all the operations of the instrument. Even circuitry regulating the power-supply voltage is on the chip.

This signal processing is accomplished in two peak detectors and a display driver. The first, or bipolar, peak detector produces an output pulse of the same amplitude as the input pulse, but always positive in polarity. It also stretches the peak of the 150-ns input pulse from about 20 ns to about 40 μs. Since this is still not sufficient to produce a visible pulse, a second peak detector is employed to stretch the output of the bipolar peak detector to about 200 milliseconds, which is quite visible. The display driver then provides a signal of proper amplitude to drive the display lamp.

Driving nodes

Sometimes an external stimulus is required, or it may be more convenient than tracing the currents generated by the logic under test. A pulse generator or any of a number of logic pulsers can be used to perform this function.

One such logic pulser is the HP model 546A. It can overdrive logic nodes with narrow pulses of controlled voltage, polarity, width, rate, and count. A single, serially encoded switch selects continuous pulse streams at 1, 10, or 100 hertz, bursts of 10 or 100 pulses with 1-second pauses between bursts, or single pulses. To program a mode, the button is pushed a set number of times in rapid succession. Holding it down after the last push causes the selected function to be executed. Sliding it forward locks it down and keeps the pulser in the selected mode. Mode-select control circuitry determines whether the instrument is in the programing, executing, or standby mode.

The overall parts count, size, power consumption, and cost of the pulser are kept low by employing a single custom chip to perform most functions. The chip (Fig. 4) contains a 256-bit read-only memory, 14 flip-flops, 41 gates, and other devices, including an on-chip voltage regulator, for a total of about 1,000 transistors on a 108-

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the anode voltage; Q_2 then fires, dumping C_3's charge through current-limiting resistor R_6 and the light-emitting diode of the photon coupler.

When the LED conducts the current pulse from C_3's discharge, it turns on transistor Q_1 in the photon coupler. Transistor Q_3 is then turned on, producing an output voltage pulse that is adequate to drive C-MOS circuitry. If transistor-transistor logic is to be driven, the pulse will require some sharpening by a buffer transistor and a Schmitt trigger such as the 7413.

Capacitor C_5 is included to provide noise immunity. There is enough common-mode noise on telephone lines to falsely switch Q_3 even after it has passed through the stray capacitance of the coupler. C_5 forms a voltage divider with the stray capacitance, reducing the noise to insignificance. ☐

Timer extends life of teletypewriter

by Bob Piankian
Massachusetts General Hospital, Boston, Mass.

The mean time between failures of a teletypewriter terminal can be extended by a circuit that turns on the motor only when information is being received or transmitted. In that way, the mechanical wear and destructive temperatures are minimized in a motor that is continuously powered-up but seldom active. Moreover, the cost of power to the terminal is significantly reduced. A teletypewriter motor consumes about \$50 worth of electricity a year. If it is only active 10% of the time, this circuit could save \$45 each year for each machine.

A logic circuit for this application is shown in Fig. 1. When no characters are being transmitted over the current loop, the MCT2 opto-isolator keeps the trigger input of the 74121 monostable multivibrator at logic 0. If characters are sent to the teletypewriter, or if the teletypewriter BREAK key is depressed, the current loop is broken, and the 74121 is triggered. This triggering fires the 555 timer, activating relay K through Darlington pair Q_1 and Q_2, thereby turning on the motor of the teletypewriter.

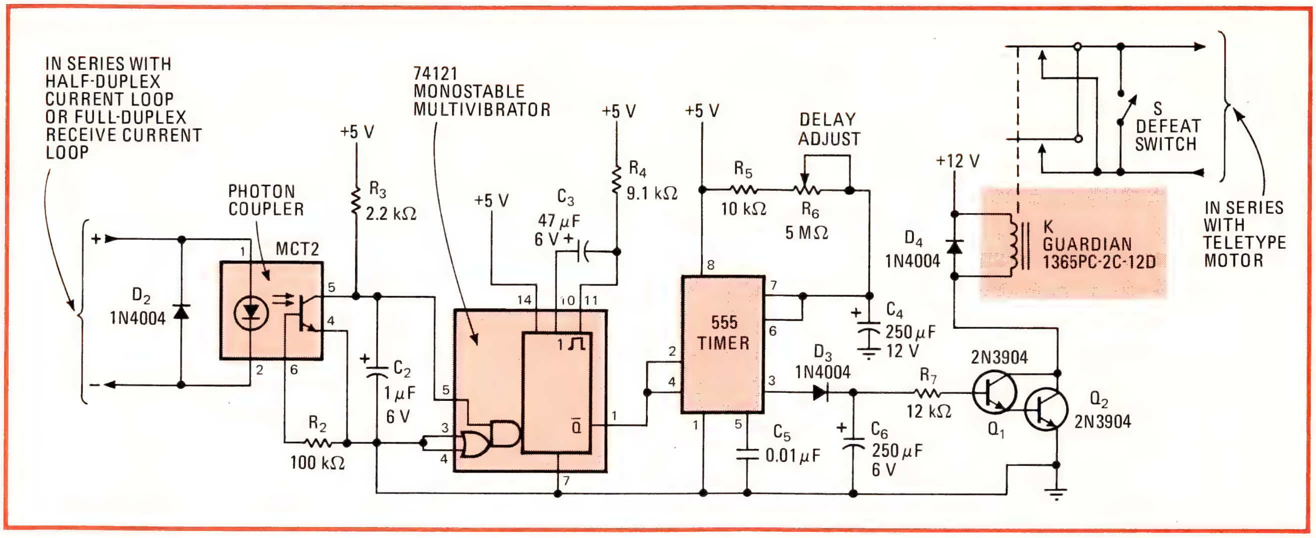
The time the motor remains energized, T, is given in seconds by $1.1(R_5 + R_6)C_4$, where C_4 is expressed in microfarads and R_5 and R_6 in megohms. Resistor R_6 adjusts the time period to between 2.5 seconds and 20 minutes.

If another character is received or the keyboard is used during the time span that the motor is energized, the monostable resets the timer and then retriggers it, keeping the teletypewriter on for another time period, T. To discharge C_4 completely during the reset process, $R_4 C_3$ should be greater than $2.4 C_4$, where R_4 is in kilohms and C_3 and C_4 in microfarads. D_3, R_7, and C_6 prevent the relay from turning off during the 0.3-second reset operation.

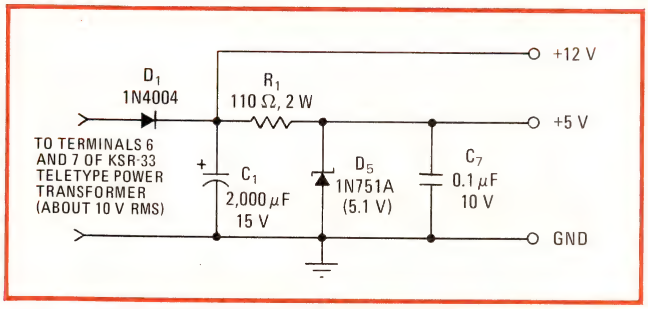
Standard current loops of 20 or 60 milliamperes can be used. Diode D_2 protects against accidental reversal of line polarity, and C_2 provides immunity from noise on the line. Defeat switch S permits normal use of the teletypewriter terminal.

Figure 2 shows the power supply for the circuit, which uses a standard transformer already in a KSR-33 Teletype. The entire circuit was built on a 3-by-3½-inch printed-circuit board and installed in many terminals. Total parts cost is about \$15 for each unit—and they pay for themselves in just a few months.

With this device installed, the power switch is left in the ON position. The system software should be changed to send a nonprinting character to the teletypewriter 1 second before actual information output so that the



1. Turn-off circuit. Teletypewriter motor remains off unless information is being received or transmitted by terminal. When current loop is broken by transmission or reception of a character, the monostable fires and triggers the timer, which turns on the motor and keeps it on for a drop-out time of up to 20 minutes. Use of this \$15 circuit saves power and prolongs teletypewriter life.


D1
1N4004
TO TERMINALS 6 AND 7 OF KSR-33 TELETYPE POWER TRANSFORMER (ABOUT 10 V RMS)
R1
110 Ω, 2 W
+
C1
2,000 μF
15 V
D5
1N751A
(5.1 V)
C7
0.1 μF
10 V
+12 V
+5 V
GND

2. Power supply. By using a few additional parts, the 5-volt and 12-volt supplies required for the circuit of Fig. 1 can be obtained from a power transformer already present in the KSR-33 Teletype terminal.

motor can come up to speed. In a half-duplex system, hitting the BREAK key starts up the teletypewriter locally. For this feature to work in a full-duplex system, the software must echo the break to the machine. Turn-off time-delay T can be changed as desired to avoid needless turn-on/turn-off cycles. ☐

Two inverters and a crystal assure oscillator start

by Ronald H. Beerbaum
Southbury, Conn.

A crystal-stabilized, transistor-transistor-logic clock source with no start-up problems can be made with two TTL inverters in the arrangement described here. The circuit has two other advantages: it will operate with almost any crystal from any manufacturer, and its stability is dependent on the characteristics of only two components.

TTL circuitry has inherently low impedance at all nodes, necessitating a series-mode oscillator configuration to provide a reasonably high Q. This mode requires a low-impedance path through 360° of phase shift with sufficient gain to overcome the losses in the loop.

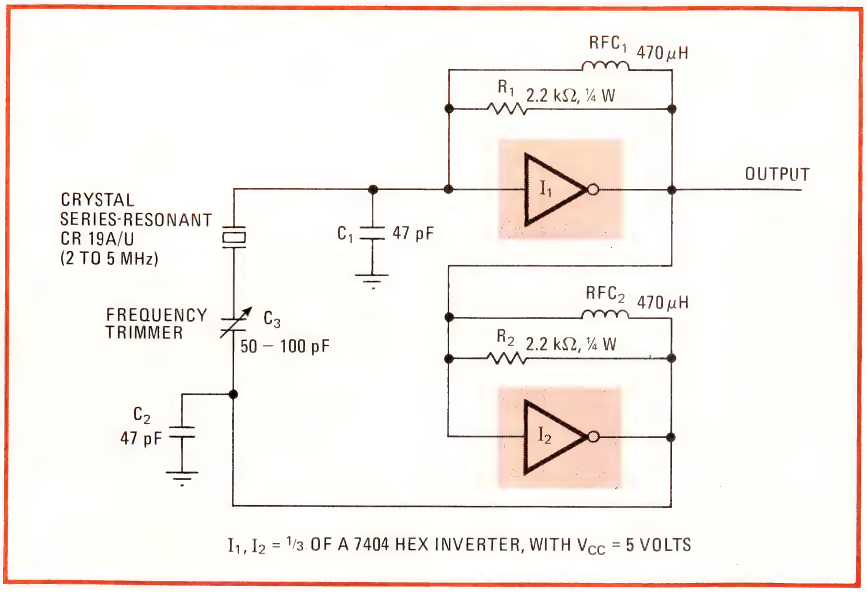
In the circuit below, I_1 and I_2 are TTL inverters (or NAND gates with the inputs tied together) that provide the necessary gain and phase inversion. RFC_1 and RFC_2 provide dc feedback at the inverters that forces them into a linear mode. These chokes are chosen to provide enough loop gain to drive a weak crystal, and should have a dc resistance on the order of 100 ohms or less. R_1 and R_2 are Q-swamping resistors inserted to eliminate oscillation of the circuit at the self-resonant frequency of the chokes. If low-Q chokes are used, these resistors may be eliminated, but it is wise to allow for them in the circuit-board layout to permit choke substitution.

Usually serial-mode crystals have three stable modes of oscillation—the one stamped on the can, one above that frequency, and one below that frequency. The higher- and lower-frequency modes are generally determined by both the crystal and distributed circuit parameters. Capacitors C_1 and C_2 are included in the circuit to eliminate these modes; by lowering the impedance of the loop they ensure that the specified frequency occurs. They have very little effect on the operating frequency, so high-quality capacitors are not required.

C_3 can be a trimmer or a fixed capacitor, depending on the exactness of frequency required. A tuning range of about 100 parts in 10^6 can be obtained by varying C_3, but temperature stability and long-term stability are dependent on its characteristics.

This circuit with the values shown will operate in the frequency range of 2 to 5 megahertz. Below this range, the values of RFC_1, RFC_2, C_1, and C_2 should be increased. Above this range C_1 and C_2 should be reduced to 22 picofarads or less. ☐

Designer's casebook is a regular feature in *Electronics*. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $50 for each item published



Reliable clock source. When power is applied to this series-mode TTL crystal oscillator, it always starts up at the right frequency. It will operate with most crystals; the components shown here are for crystals in the 2-to-5-MHz range.

Predicting the real costs of semiconductor-memory systems

Storage costs are rising steadily in computer systems as large-scale integration continues to increase the capacity of RAM chips

by Robert J. Koppel and Irwin Maltz, *Intersil Inc., Sunnyvale, Calif.*

☐ Designers and manufacturers of computer systems are finding that memory is increasing in importance in determining lifetime costs of an installation. On the one hand, unit prices are being steadily decreased by the declining price of semiconductor random-access memories as advances in technology are enabling designers to cram more and more capacity into smaller and smaller space.

But as the cost per bit is being driven downward, more storage is being used in most systems. The resulting memory cost as a percentage of the complete computer installation is continuing to climb.

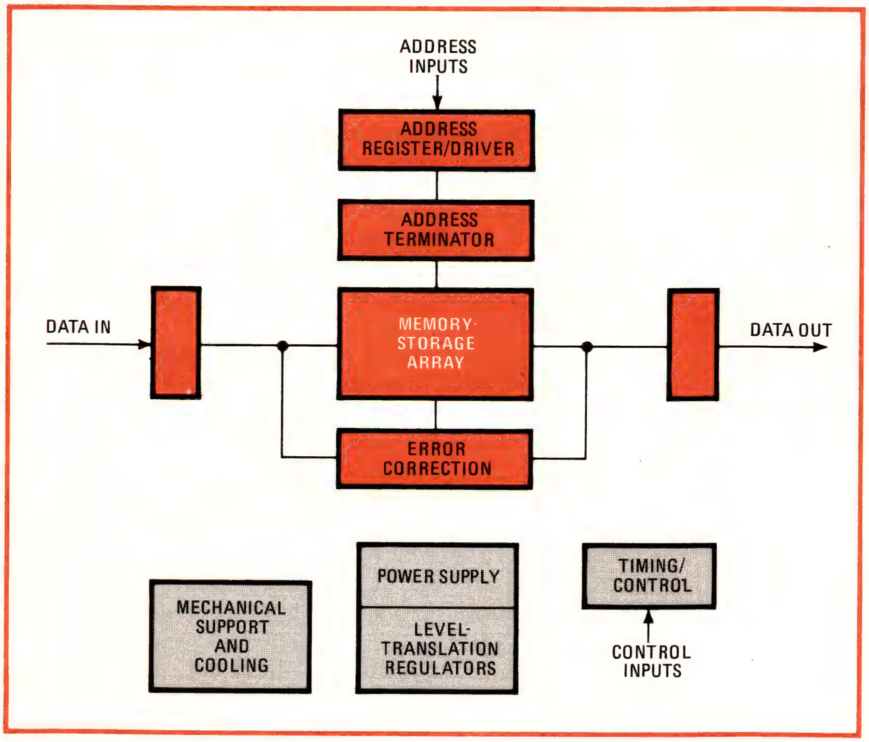
The lifetime of a computer system can be extended and its life-cycle cost minimized if its memory is constructed in modules to allow for incremental upgrading. What's more, lifetimes can be extended and the costs of maintenance kept low by using the right testing procedures during manufacture and providing for adequate system cooling.

The subsystems of a typical memory are shown in Fig. 1. Production and maintenance expenses are determined primarily by:

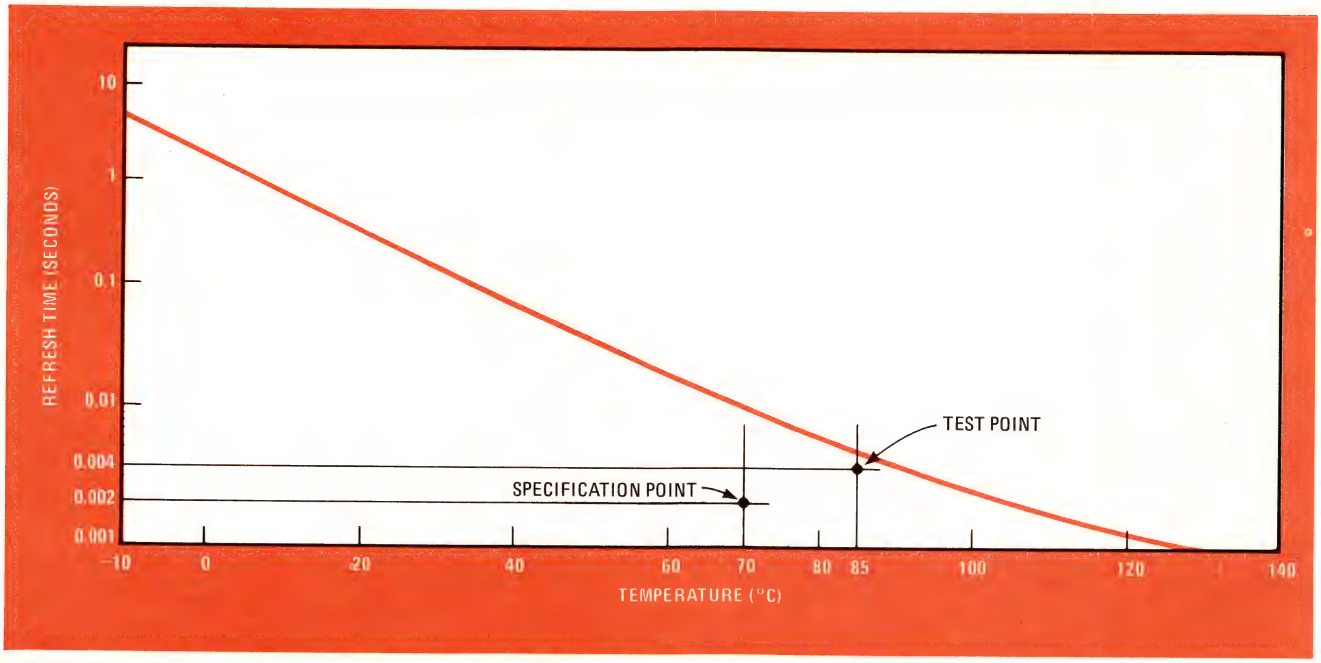
- The need for device testing and the resulting effect on reliability.
- Error-correction techniques.
- The optimum size of memory modules to provide for the incremental growth of the system.
- The memory devices themselves and their supporting electrical and mechanical equipment.
- The power supply.

Evaluating reliability

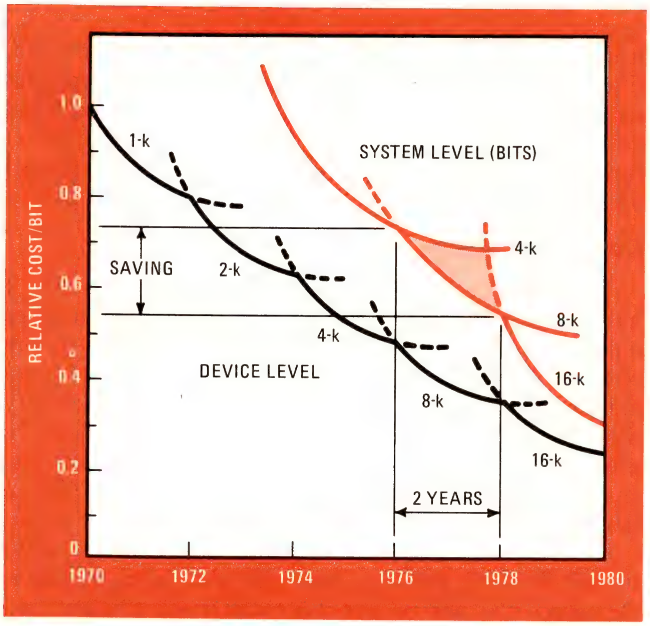
Two of the major causes of memory-system failures are related to parameter instability in random-access memories and lack of initial testing of the devices. Standard test procedures in MOS manufacturing, such as the capacitance-voltage (C-V) plots and accelerated-temperature tests, have been optimized to weed out potentially unstable wafers or wafer lots. Since the source of instability is either contamination or disloca-



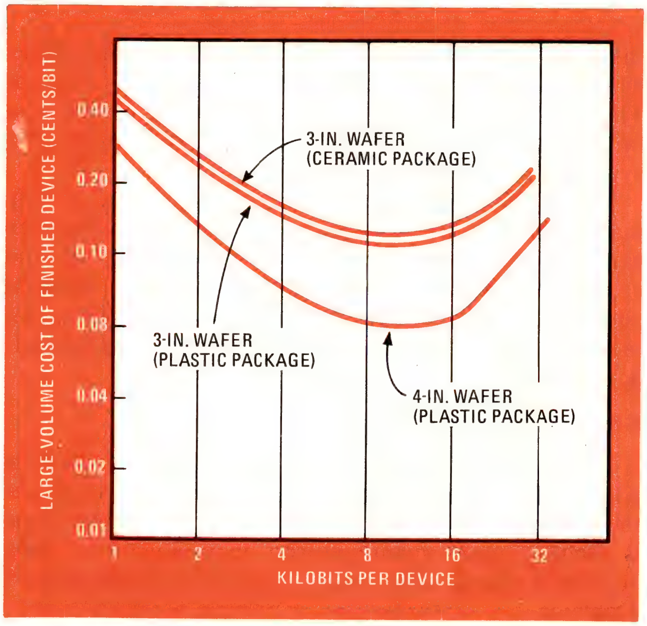
1. Memory system. A typical memory system is much more extensive than the storage array. When estimating the over-all system cost, support circuitry such as drivers, decoders, power supply, and cooling equipment must be considered. Often, error-correction circuitry is also included.



3. Refreshing. The refresh time interval for a typical 4-k RAM depends upon temperature. Devices should be tested at a higher temperature and longer refresh time than is specified. A device successfully tested at 85°C and 4 ms is reliable at the shorter operating interval.



4. Price projections. Each generation of memory devices has reduced storage costs by an increasingly larger percentage. The 16-k RAM will be about 33% less costly than the 8-k chip, although the 4-k was only 25% less costly than the 2-k part.



5. Cost and capacity. Estimated costs for devices of various capacities in 1977 show that minimum costs per bit will be reached for 8-k and 16-k devices. These curves are based upon such factors as mask quality, wafer size, and package type.

(point A). For that reason, systems should be operated at the lowest ambient temperature permitted by the economics of cooling.

The effect of the proper testing on RAM devices can be quite dramatic. Parts received from some sources yield 1% fallout through component and system testing, while parts from other sources yield as much as 10% to 15% fallout for the same testing. If the user fails to test carefully, that 10% to 15% could fail in the field. A failure rate that high could be disastrous. This threat justifies burn-in of all finished memory cards before they are shipped. Intersil cards are typically burned in for 24 hours at 50°C.

The company is also performing a thermal-shock test on all cards, which is particularly important for the peripheral devices. This test includes a 10-cycle thermal shock at −40°C to +70°C with one-hour stabilization at each end for all storage boards before the memory devices are inserted. This procedure is followed by functional card testing burn-in, final card test, and then system test.

Every system also is burned in for 24 hours, with the

Dynamic RAMs are superior

Even though dynamic random-access memories are cheaper and more reliable than static RAMs, designers appear to be reluctant to use them. A certain percentage of users won't consider the dynamic part because they don't trust its capability to retain data.

Admittedly, some computer designs do not allow for periods when the memory is unavailable because it is being refreshed. For instance, if a system is accepting data from a drum at high speed for storage, some data is lost during the refresh cycle because there is no place to put it. In this type of application, the static RAM is essential.

However, a system can be designed so that the refresh time of the dynamic RAM never interferes. In many systems, the lost time is well below 0.5% of the processing time, a period that is essentially unmeasurable. What's more, the dynamic RAM is generally more reliable than the static one. The dynamic device requires significantly less power, and keeping power dissipation low is the most important factor involved in ensuring device reliability. Smaller chip size is another factor that points in favor of dynamic devices.

The complexity and cost of dynamic-RAM systems can be substantially reduced by using recently available single packages, each containing clock drivers and refresh circuits, along with the special medium-scale integrated circuits. Costs of static and dynamic RAMs, at 1977 prices, are compared in the table.

Dynamic (7280)		Cost item	Static (7114)
$256	(64 @ $4)	RAMs	$384 (64 @ $6)
55	(42 ICs)	Support circuits	40 (36 ICs)
10.18	0.4 in.^{2}/RAM 0.36 in.^{2}/support ckt 0.25 cents/in.^{2}	Circuit board	9.64
150	+12 V @ 0.4 A + 5 V @ 0.4 A − 5 V @ 0.02 A	Power supply	100 +5 V @ 5 A
60	(2.7 hours)	System assembly/test	42 (2.0 hours)
$531.18		Total direct cost	$575.64
159.35	30%	Overhead	172.69 30%
$690.53		Total cost to manufacture	$748.33

small machine to only once a year and virtually eliminates emergency repairs.

The addition of ECC for a 64-bit-word system typically requires about 15% more hardware for the extra storage and circuitry, while a 16-bit word requires 35% additional hardware. The designer should trade that off against the potential maintenance costs and customer satisfaction if the particular application permits the option.

Although there is typically also a speed penalty of 75 ns in read- and write-cycle times because of the extra logic levels accompanying ECC, the technique is becoming popular in memories with short words. As the price per bit continues its 25% to 30% decline per year, the extra bits and the associated logic required for ECC are becoming almost insignificant, compared with the cost of an emergency service call if the memory should fail.

Designing modules

A major problem arises in choosing the size of the smallest useful increment of card size in addition to the size of the BSM (basic storage module), which is a group of cards, and most BSMs contain 128 kilobytes or more. The BSM is frequently not large enough to fully utilize the capability of available drivers and sense circuits. If the module is too small, the designer is faced with the choice of placing these auxiliary circuits on a separate control board to supply several memory boards, or simply accepting the cost penalty of excess capability so that he can offer a single board type for memories of all sizes.

For most large systems, today's cards may contain 64 kilobytes, each organized as 32 kilowords by 18 bits. This capacity offers optimum combinations of RAMs and lowest non-storage costs. It also permits upgrading in the field by the addition of cards to the largest capacity and performance demands likely to be required in this decade.

At this 64-kilobyte capacity, the card is large enough to fully utilize the peripheral driver and sense circuits that support the storage devices. In fact, by simple card redesign and back-panel changes, the same circuits can support either 8-k RAMs, which represent the next devices optimized for speed and density, or 16-k RAMs, the next higher level of devices optimized for cost and density.

For 32-k-by-18-bit cards, the storage array may be large enough to fully utilize the capability of available driver and sense circuits, but the timing and control circuits can effectively drive as many as four storage cards. For that reason, one control card for each four storage cards is usually specified, and the exact ratio is determined by the system-speed requirements for a particular application.

Small-card memories—4-k by 8 bits for microprocessor applications—have the entire system, including control circuitry, mounted on a single card. However, a gray area exists in moderate-size systems—16-kilobyte cards and higher. Some manufacturers offer separate control cards, and others mount the control circuits right on the storage cards.

Estimating system costs

In estimating the cost of a memory system, it is important to distinguish between storage costs—for the memory chips themselves—and non-storage costs, which represent the supporting electronics, for such purposes as data and address buffering, error correction, timing, control, and power, as well as mechanical support and cooling equipment (see Fig. 1). Storage costs are coming down much more rapidly than non-storage costs; in fact,

Broadband matching transformers can handle many kilowatts

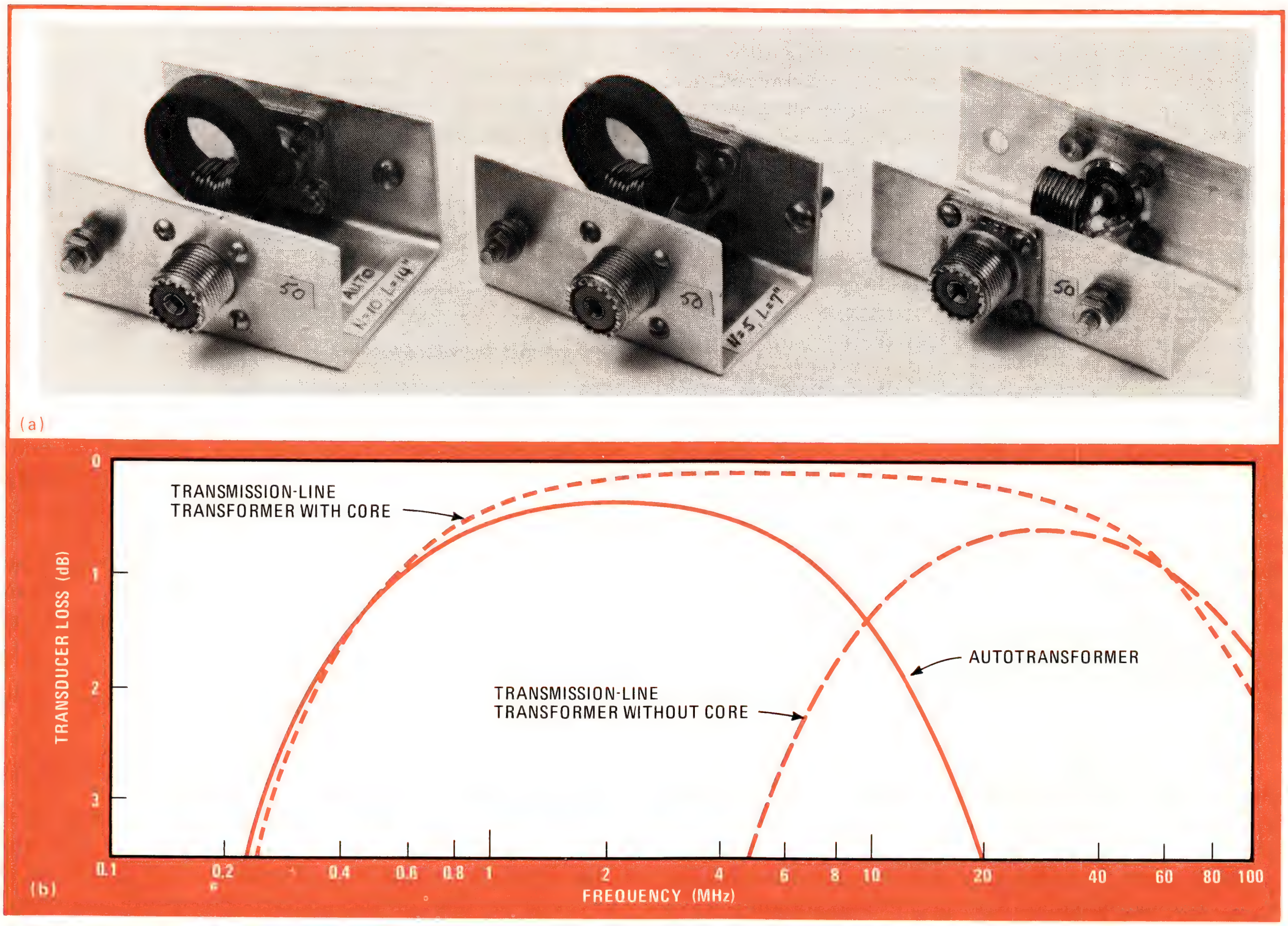
The discovery that transformers with transmission-line windings have 98% efficiencies opens up new uses for them in high-power applications

by Jerry Sevick, *Bell Laboratories, Murray Hill, N.J.*

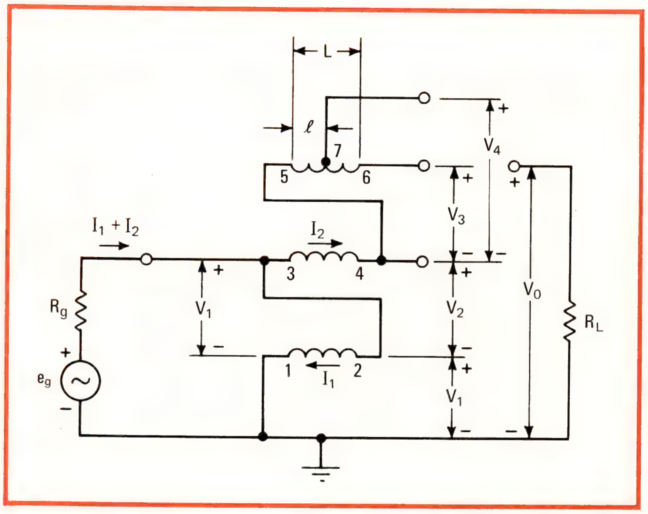
☐ The big news about broadband matching transmission-line transformers is their ability to deal with many kilowatts of power. On investigation, their efficiency turns out to be much higher than anyone had suspected—an astonishing 98% over most of a frequency range spanning several hundred kilohertz to 100 megahertz. Also news is the fact that they can be built with fractional impedance transformation ratios.

The small rugged devices, made of a short length of transmission line coiled around a single magnetic core, are in wide use because of their inherently large bandwidth. Now their applications should be extended in particular to matching high-power amplifiers to an antenna, as well as matching small-signal amplifiers.

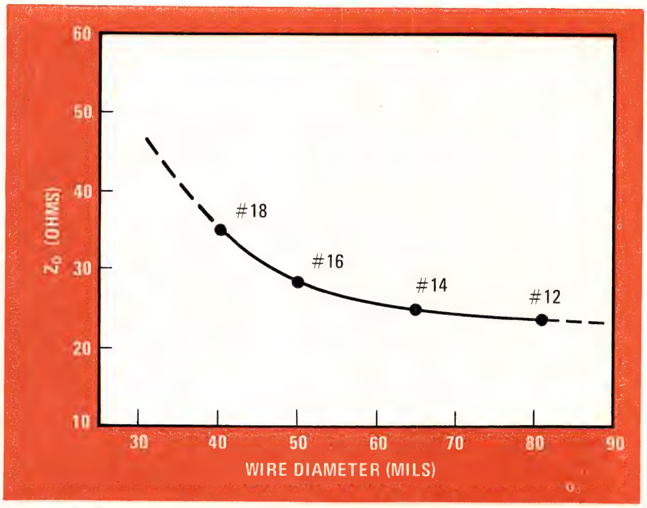
Experience long ago showed that other broadband matching devices—whether networks of capacitors and inductors or conventional transformers—had smaller bandwidths and lower efficiencies. High ohmic loss characterizes inductors of the size needed at low frequencies. High core loss in conventional transformers



1. No magnetic coupling. The curves plotted for three types of transformers show that the transmission-line type with a toroidal core has good efficiency even at the very-low-frequency end, proving that there is considerable energy transferred by the transmission-line mode. At higher frequencies the core provides increased efficiency and bandwidth by preventing unwanted shunting currents.



3. Other ratios. A 4:1 impedance ratio results when the transmission-line transformer's output is connected between ground and terminal 4, 9:1 when it is connected between ground and terminal 6. Tapping off the top winding (terminal 7) yields non-integer ratios.



4. Experimental data. Characteristic impedance Z_O is plotted for closely wound coils of the size of wire used in power applications. Twisting the wires together decreases Z_O slightly; reducing the spacing between adjacent pairs lowers Z_O as much as 40%.

is contained in this analysis. In the transmission-line mode, the magnetic fields cancel at high frequencies, so that almost no flux threads the core.

However, the core's effect needs stating at low frequencies. At this end of the range, the transformer's response is determined mainly by the reactance of the bottom winding to the flow of a shunting current. If the reactance is made large enough, only transmission-line current will flow, and the impedance transformation ratio will be maintained.

One way to increase reactance would be to increase the number of turns of the transmission line, but that would lengthen it and so degrade its high-frequency performance. The preferred way is to use high-permeability core material, particularly in the case of a toroidal configuration.

The model for the low-frequency region can then be represented by an inductance in parallel with an ideal transformer. In mathematical terms:

$$\frac{\text{available power}}{\text{output power}} = \frac{R_g^2 + 4X^2}{4X^2} \qquad (2)$$

where X is the reactance of the bottom winding with the secondary open-circuited.

A different mechanism

Although this equation is identical to that for the low-frequency response of the conventional transformer, the modes of operation are different. The transmission-line transformer, for as long as it is transferring considerable quantities of power at low frequencies, is still acting like a transmission line and not like a conventional transformer, which transfers power entirely by the common flux linkage. But it may start acting as an autotransformer at still lower frequencies if it experiences appreciable core flux and the choking action is inadequate to prevent the generation of excessive currents in the bottom winding.

The analysis of the transmission-line transformer's operation need not stop here. If it is carried a step further, it is possible to show that single-core transmission-line transformers can be constructed with integer impedance ratios of other than 4:1 and even with non-integer impedance ratios—in other words, with fractional impedance ratios.

Figure 3 presents the model for the extended analysis, which employs the same sort of loop equations as before. In this case, three windings are used, instead of two, and the associated voltages V_1, V_2, and V_3 are summed across the load. Conventional transmission-line equations determine V_2 with respect to V_1, as well as V_3 with respect to V_2. Output voltage V_O is determined from two transmission lines of equal lengths, not from one transmission line of twice the length. The voltages simply add when transmission lines are short—V_O is three times larger than the input voltage V_1, and I_1 is twice as large as I_2, complying with the principle of the conservation of energy. Also, the flux from the bottom winding tends to cancel the flux from the other two, minimizing core losses. The result is an impedance transformation ratio of 9:1.

Obtaining fractional ratios

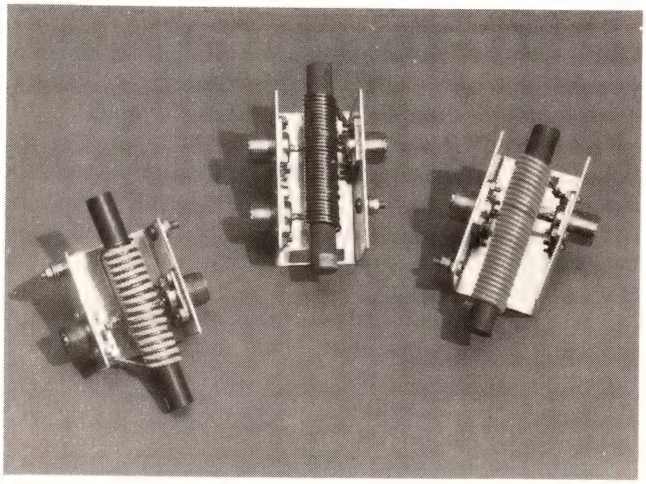
Impedance ratios of other than 9 or 4 to 1 become possible if the top winding is tapped. Since all windings are tightly coupled electrically, a common voltage gradient of V_1 exists from left to right along the windings, and the voltage at the tap, terminal 7, becomes $V_O = V_1 + V_2 + V_4$. Now $V_1 = V_2$, and $V_4 = (l/L)V_1$, where L is the length of the transmission line and l the length to the tap. Consequently:

$$V_O = V_1(2 + l/L)$$

To generalize this equation, let n = the number of windings below the top winding which is tapped so that:

$$V_O = V_1(n + l/L)$$

Rod-core transformers allow for fractional turns, so their l can have any value up to L. But for toroidal-core



6. Varying the impedance ratio. Two-winding step-up transmission-line transformers provide a 1.55:1 ratio (left) and a 2:1 ratio (right), while a three-winding transformer (middle) can provide either a 9:1 or 4:1 ratio. All three devices were wound with 14-gauge enameled wire on ½-inch-diameter, 4-inch-long ferrite rods. The frequency response of each of the transformers is plotted in Fig. 7.

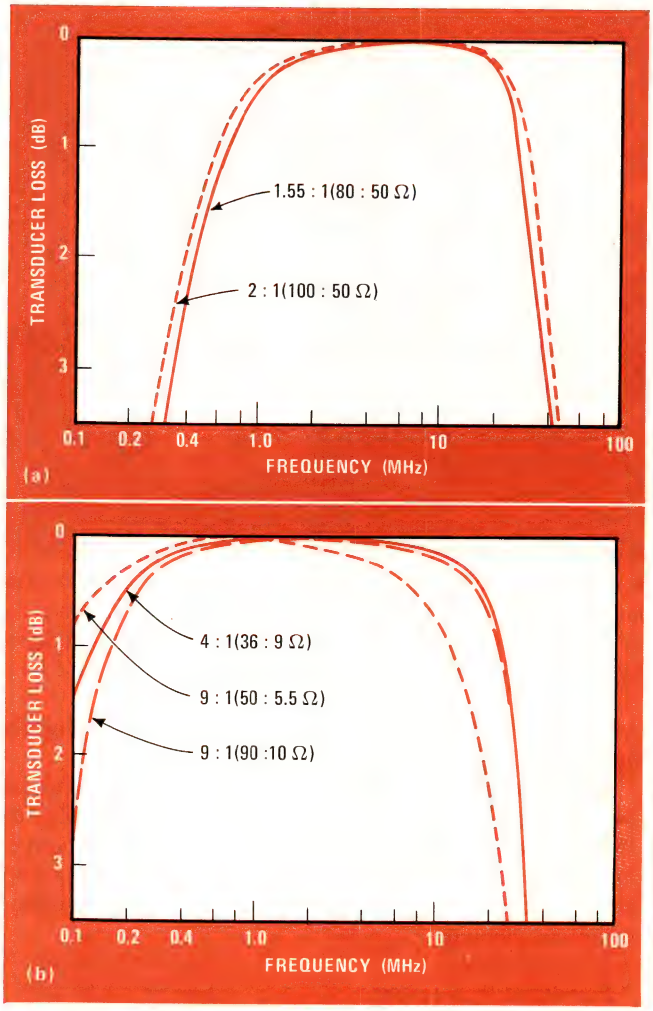
spacing of the windings; the shunting inductance that affects low-frequency rolloff and itself depends on the size and type of core material; and the effective phase constant of the coiled transmission line, which determines the transformer's high-frequency response and depends on the dielectric of the wire insulation and coupling between windings.

As already noted, the optimum value for the characteristic impedance of the transmission line of a 4:1 matching transformer is the geometric mean of the input and output resistance, $Z_O = (R_g R_L)^{1/2}$. Initial results for fractional-ratio designs indicate that for them, too, the optimum values of Z_O are the geometric means of their input and output resistances. It has been found that generally, with characteristic impedances of twice or half the optimum value, the transducer loss is less than 0.2 dB with short transmission lines of 0.09 λ or less.[2] The author found experimentally that little degradation is observed at the high-frequency cutoff with departures as large as 10% from the optimum value of Z_O. The characteristic impedance, however, does vary with frequency because the permeability of the core material is frequency-sensitive. Usually the optimum value of Z_O should be determined at the highest frequency of operation.

To lower the characteristic impedance, should that be necessary, transmission lines can be twisted together. Twisting them lowers Z_O by increasing their distributed capacitance. A more significant change, however, can be made by just tightly coiling the transmission lines and so minimizing spacing between windings.

How to adjust Z_O

Figure 4 shows experimental data for various tightly wound, bifilar coils of typical wire sizes used in power step-down applications. For instance, Z_O can be lowered about 40% by reducing the spacing between adjacent pairs of wires from three wire-diameters to that of the insulation of the wires.



7. Plotting response. The characteristic impedance is optimum for the 4:1 transformer but for the 9:1 transformer only when matching 90 to 10 ohms, not 50 to 5.5 ohms. For the latter case this less-than-optimum impedance causes a more rapid falloff at high frequencies, but, since an inductive reactance of only 5.5 ohms, not 10 ohms, has to be exceeded, the low-frequency end is improved.

For step-up transformers to maintain high-frequency performance, however, larger winding separations are necessary. This can be done by separating the turns with extra insulation, such as Teflon tubing, to increase the characteristic impedance. For example, tightly wound turns, separated by Teflon sleeving, approach a Z_O of 70 ohms and are useful in step-up transformers that must match 50 ohms or more.

The core's role

Shunting inductance varies with the geometry and permeability of the transformer's core material. To define the core role more closely, three 4:1 matching transformers were tested (Fig. 5). Two used toroidal cores, and one used a solenoid. One toroid was of Q1 ferrite material with an outer diameter of 2.4 in. and a thickness of ½ in. The other toroid was powdered iron (Carbonyl E, μ = 10 nominally) with an outer diameter of 2 in. and a thickness of a little less than ½ in. The solenoid was a rod of ferrite material, ⅝ in. in diameter and 4 in. long. (Various lengths of rod were tried, but

Who's the performance winner in 16k and 32k memory systems?

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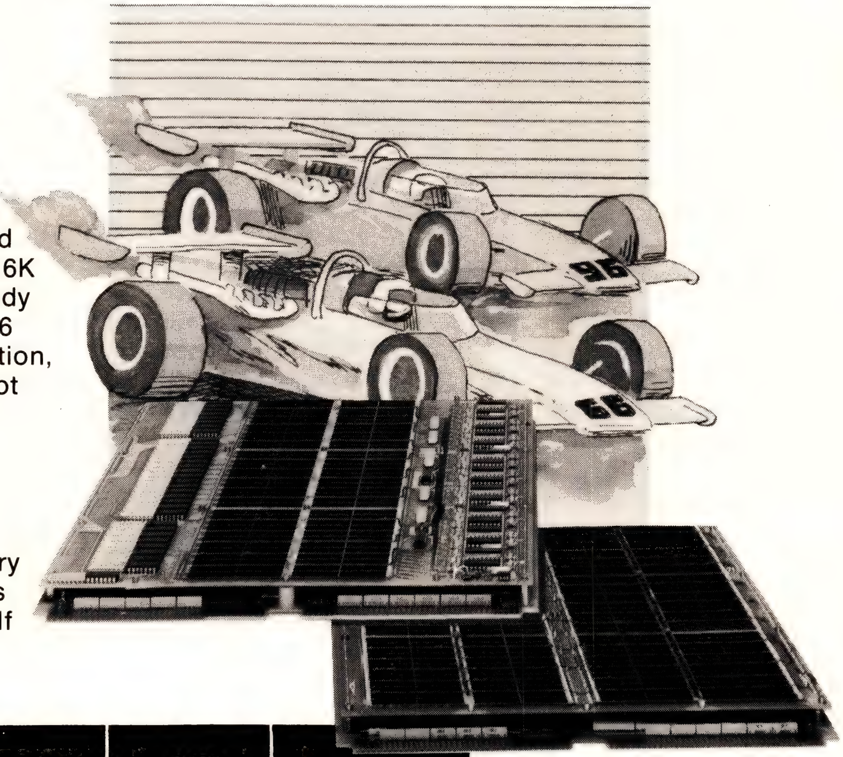

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MODEL	696	698	Micro 3000 D.D.	Micro 3000 Q.D.	Store 1680		DR-103	DR-103
MEMORY SIZE	16K	32K	16K	32K	16K	32K	16K	32K
CYCLE TIME	650	650	650	850	650		650	750
ACCESS TIME	250	250	270	300	280		265	300
PHYSICAL SIZE	11.75x15.4 x1.0	11.75x15.4 x1.0	11.75x15.4 x1.0	11.75x15.4 x1.0	11.75x15.4 x1.0		11.5x13.7 x1.0	11.5x13.7 x1.0
COMPATIBILITY 16K TO 32K	YES		NO		NO		NO	

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RESPONSES OF LOGIC PROBE

Input condition	Output indication	
	Red LED	Green LED
Open circuit (Hi-Z)	Off	On
Logic 0	Off	Off
Logic 1	On	Off
Pulse train	Flashes at 2.5 Hz	Off

distinguished from constant-dc levels, will therefore flash the red LED at the 2.5-Hz rate.

The probe input is protected from negative-polarity signals by R_2 and D_2. The unit, which will operate from any 5-v to 15-v source, is protected against overvoltage by D_5 and R_1 and against the wrong supply-voltage polarity by D_1. Logic-level thresholds are about 20% and 80% of the supply voltage, and the probe draws only about 10 milliamperes from a 5-v source. ☐

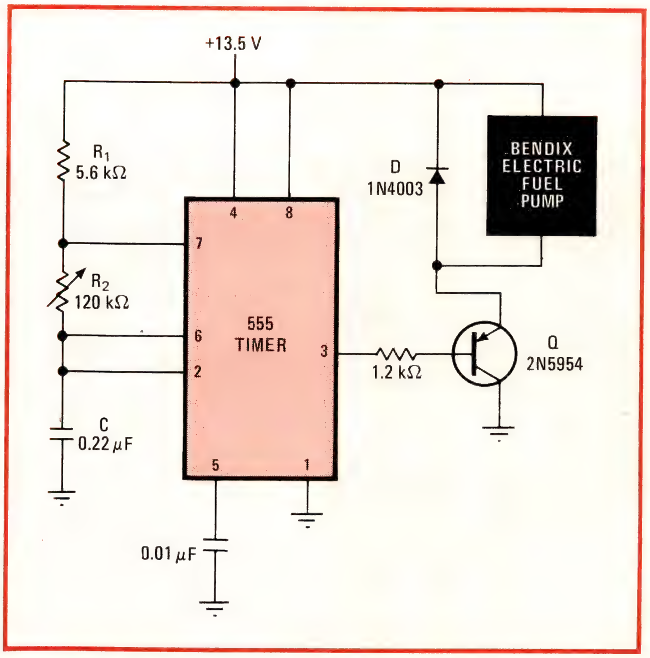
IC timer drives electric fuel pump

by Sudarshan Sarpangal
ISRO Satellite Systems Project, Bangalore, India

A 555 integrated-circuit timer and a transistor provide an efficient driving system for a high-speed electric fuel pump. This arrangement allows the pumping rate to be adjusted and can be used with any pump of the solenoid-plunger type.

As the schematic diagram shows, the timer and components R_1, R_2, and C form a basic square-wave oscillator circuit. The output at pin 3 drives transistor Q on and off and so operates the solenoid-driven plunger of the pump. Commutating diode D protects the transistor from surges at turnoff.

The components shown are used to drive a Bendix fuel pump at 16 strokes per second, with the speed adjustable by change of R_2. If a different pump is used that requires current of more than 1 ampere, a different transistor must be chosen. ☐



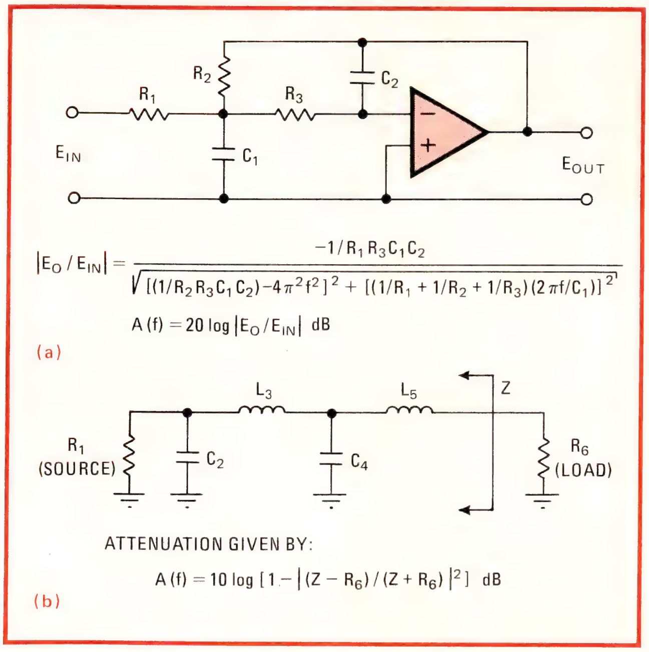
Adjustable-speed pump driver. This IC timer arrangement drives the Bendix plunger-type electric fuel pump at a rate of 16 strokes per second. Adjustment of R_2 permits other pumping rates.

Calculator notes

Programable calculator analyzes filter designs

by Tom Martin
Collins Radio, Dallas, Texas

An SR-56 calculator can provide a quick check on low-pass circuits laid out with the excellent filter-design programs in its applications library or on any other active or passive low-pass filter with up to four components. The calculator can be programed to analyze the performance of these filter circuits, giving the gain or


R1
R2
R3
C2
C1
−
+
EIN
EOUT
$|E_O/E_{IN}| = \frac{-1/R_1R_3C_1C_2}{\sqrt{[(1/R_2R_3C_1C_2)-4\pi^2f^2]^2 + [(1/R_1 + 1/R_2 + 1/R_3)(2\pi f/C_1)]^2}}$
$A(f) = 20 \log |E_O/E_{IN}|$ dB
(a)
L3
L5
Z
R1
(SOURCE)
C2
C4
R6
(LOAD)
ATTENUATION GIVEN BY:
$A(f) = 10 \log [1 - |(Z - R_6)/(Z + R_6)|^2]$ dB
(b)

Circuits analyzed. The frequency responses of the active low-pass filter in a and the passive low-pass filter in b are quickly plotted by use of the programs given for the SR-56 calculator. The decibel value of A(f) is displayed at a chosen initial frequency f_1 and at successive incremented frequencies $(f_1 + \Delta f)$, $(f_1 + 2\Delta f)$ . . . as the R/S key is pushed repeatedly.

attenuation at an incremental frequency each time the R/S key is pushed.

The theory of operation for the active-filter analysis is straightforward. It simply solves the gain-versus-frequency equations that are shown along with the circuit diagram in part a of the figure. The program (Table 1) includes provision for entering a starting frequency, f_1, and a frequency step size, Δf. Then simply pressing R/S repeatedly produces the data for plotting a linear frequency-response graph.

The passive-filter analysis works by calculating, at each frequency, the complex impedance that is seen looking back into the filter network from the load, as illustrated in part b of the figure. This filter impedance and the load resistance are then used in the equation given below to calculate the attenuation through the circuit.

The passive-filter program (Table 2) also provides for rapid plotting of frequency response curves, using f_1 and Δf. For filters with fewer than four reactive elements, zeroes should be inserted in place of the unused element values. The run time for this program is about 8 seconds for each frequency. □

Engineer's notebook is a regular feature in *Electronics*. We invite readers to submit original design shortcuts, calculation aids, measurement and test techniques, and other ideas for saving engineering time or cost. We'll pay $50 for each item published.

TABLE 1: SR-56 PROGRAM FOR ANALYSIS OF ACTIVE LOW-PASS FILTER

LOC	KEY	LOC	KEY	LOC	KEY
00	*STO*	30	*RCL*	60	*X*
01	*7*	31	*0*	61	*RCL*
02	*RCL*	32	*1/x*	62	*6*
03	*2*	33	*+*	63	*+/–*
04	*X*	34	*RCL*	64	÷
05	*RCL*	35	*1*	65	*RCL*
06	*3*	36	*1/x*	66	*0*
07	*X*	37	*+*	67	=
08	*RCL*	38	*RCL*	68	|x|
09	*4*	39	*2*	69	*LOG*
10	=	40	*1/x*	70	*X*
11	*1/x*	41	=	71	*2*
12	*STO*	42	÷	72	*0*
13	*6*	43	*RCL*	73	=
14	÷	44	*3*	74	*STO*
15	*RCL*	45	*X*	75	*8*
16	*1*	46	*2*	76	*RCL*
17	–	47	*X*	77	*5*
18	*RCL*	48	π	78	*SUM*
19	*7*	49	*X*	79	*7*
20	x^2	50	*RCL*	80	*RCL*
21	*X*	51	*7*	81	*8*
22	*4*	52	=	82	*R/S*
23	*X*	53	x^2	83	*GTO*
24	π	54	*+*	84	*0*
25	x^2	55	*RCL*	85	*2*
26	=	56	*9*		
27	x^2	57	=		
28	*STO*	58	$\sqrt{x}$		
29	*9*	59	*1/x*		

REGISTERS	
0	R_1
1	R_2
2	R_3
3	C_1
4	C_2
5	Δf
6	*temporary*
7	*temporary*
8	*temporary*
9	*temporary*

STEP	PROCEDURE	ENTER	PRESS			DISPLAY
1	*enter program, initialize*		*CLR*	*CMS*	*RST*	
2	*enter data*	R_1	*STO*	*0*		
		R_2	*STO*	*1*		
		R_3	*STO*	*2*		
		C_1	*STO*	*3*		
		C_2	*STO*	*4*		
	↓	Δf	*STO*	*5*		
3	*enter initial frequency*	f_1	*R/S*			$A (f_1)$
4	*continue*		*R/S*			$A (f_1 + \Delta f)$
						$A (f_1 + 2\Delta f)$
	↓		↓			↓

Note: For single-frequency analysis, enter the frequency and press RST, then R/S.

TABLE 2: SR-56 PROGRAM FOR ANALYSIS OF PASSIVE LOW-PASS FILTER

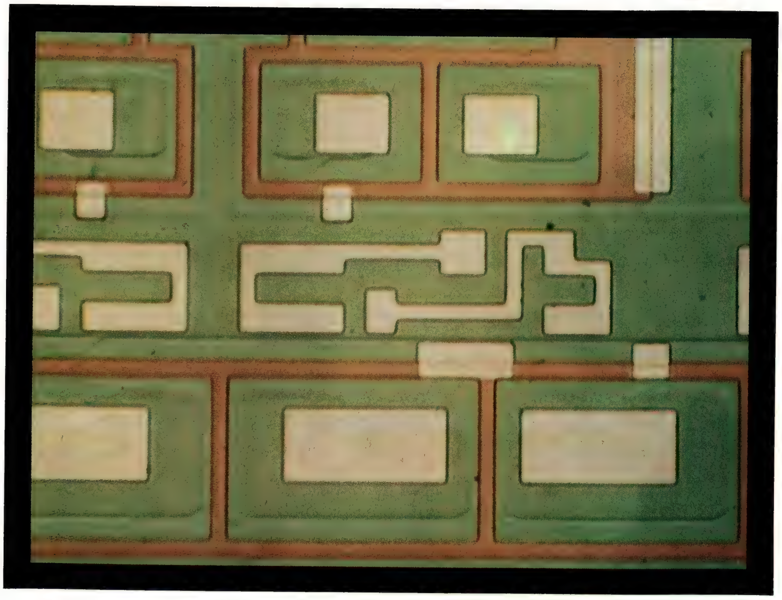
LOC	KEY	LOC	KEY	LOC	KEY	LOC	KEY
00	*X*	30	*7*	60	=	90	*PROD*
01	π	31	*5*	61	*LOG*	91	*9*
02	*X*	32	*SUBR*	62	*X*	92	*RTN*
03	*2*	33	*8*	63	*1*	93	x^2
04	=	34	*1*	64	*0*	94	*+*
05	*SUM*	35	*RCL*	65	=	95	*RCL*
06	*0*	36	*6*	66	*R/S*	96	*9*
07	*RCL*	37	*INV*	67	*CLR*	97	x^2
08	*1*	38	*SUM*	68	*STO*	98	=
09	*1/x*	39	*8*	69	*8*	99	*RTN*
10	*SUM*	40	*X*	70	*STO*		
11	*8*	41	*2*	71	*9*		
12	*RCL*	42	*+*	72	*RCL*		
13	*2*	43	*RCL*	73	*7*		
14	*SUBR*	44	*8*	74	*RST*		
15	*7*	45	=	75	*X*		
16	*5*	46	*SUBR*	76	*RCL*		
17	*RCL*	47	*9*	77	*0*		
18	*3*	48	*3*	78	=		
19	*SUBR*	49	*1/x*	79	*SUM*		
20	*7*	50	*X*	80	*9*		
21	*5*	51	*(*	81	*RCL*		
22	*RCL*	52	*RCL*	82	*8*		
23	*4*	53	*8*	83	*SUBR*		
24	*SUBR*	54	*SUBR*	84	*9*		
25	*7*	55	*9*	85	*3*		
26	*5*	56	*3*	86	*1/x*		
27	*RCL*	57	*+/–*	87	*PROD*		
28	*5*	58	*+*	88	*8*		
29	*SUBR*	59	*1*	89	*+/–*		

REGISTERS	
0	$2\pi f$
1	R_1
2	C_2
3	L_3
4	C_4
5	L_5
6	R_6
7	Δf
8	*temporary*
9	*temporary*

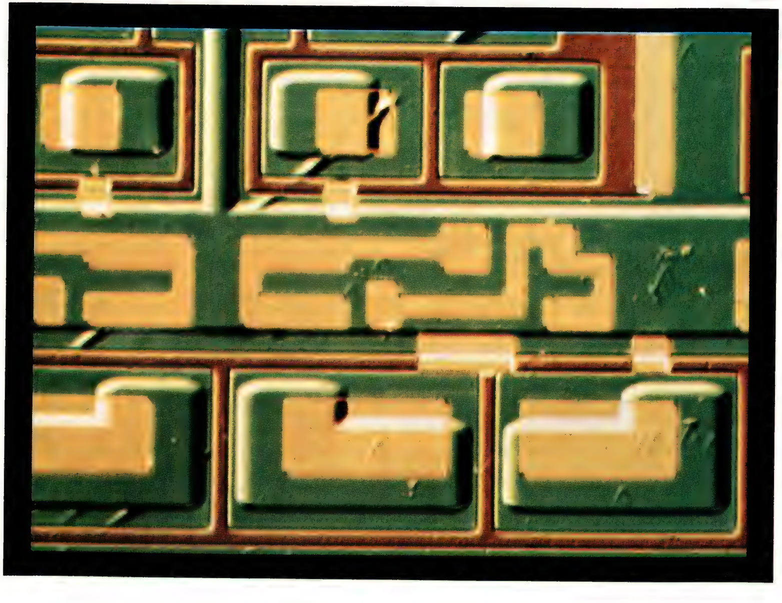
STEP	PROCEDURE	ENTER	PRESS			DISPLAY
1	*enter program, initialize*		*CLR*	*CMS*	*RST*	
2	*enter data*	R_1	*STO*	*1*		
		C_2	*STO*	*2*		
		L_3	*STO*	*3*		
		C_4	*STO*	*4*		
		L_5	*STO*	*5*		
		R_6	*STO*	*6*		
	↓	Δf	*STO*	*7*		
3	*enter initial frequency*	f_1	*R/S*			$A (f_1)$
4	*continue*		*R/S*			$A (f_1 + \Delta f)$
			R/S			$A (f_1 + 2\Delta f)$
	↓		↓			↓

Note: For single-frequency analysis, press CLR, STO 0, STO 8, STO 9; enter the frequency, press RST, R/S.

If this is all you're seeing,



this is what you're missing



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The same standards of quality and product flexibility go into the 26EM DC motor. It's a miniature motor designed with low inertia operational characteristics. And just one of a line that ranges up to the 500VM, a motor capable of accelerating to 4000 RPM and stopping over 1000 times per second.

If you'd like more information on any of these components, contact your nearest MICRO SWITCH Branch Office or Authorized Distributor.

And find out how you can get a component that goes on forever. Or at least comes very, very close.

MICRO SWITCH

FREEPORT, ILLINOIS 61032

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MICRO SWITCH products are available worldwide through Honeywell International.

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For more information on CHAMP mass-termination connectors, just call Customer Service at (717) 564-0100. Or write AMP Incorporated, Harrisburg, PA 17105.

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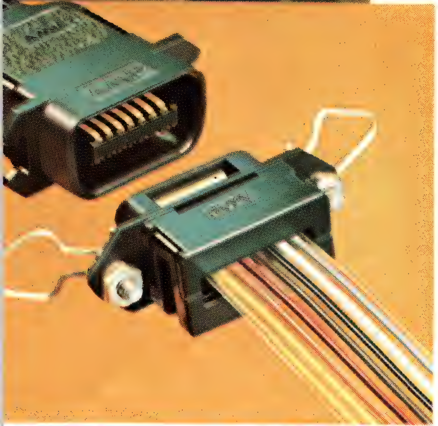

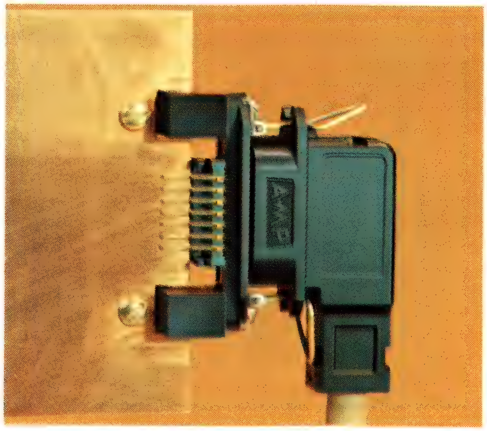

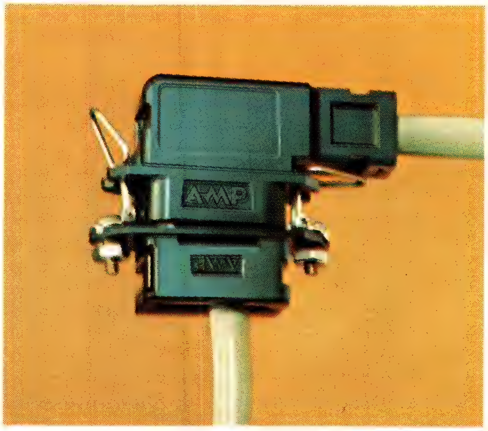

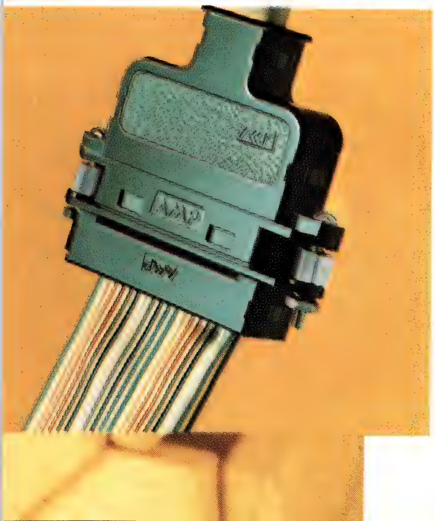

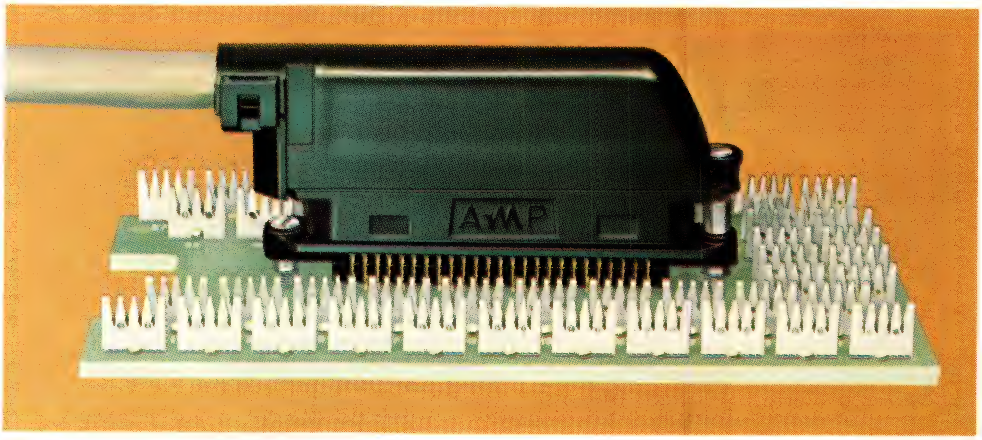

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Circle 139 on reader service card

Microcomputer gets analog I/O card

Input/output interface plugs into card cage of 80/10 one-board system for process control, laboratory experiments, other applications

by Lawrence Curran, Boston bureau manager

Users of microcomputer systems are often more at home in the digital than the analog world. However, planners at Analog Devices Inc. estimate that fully 40% of those who work with Intel Corp.'s widely used SBC-80/10 single-board microcomputer require analog interfacing for applications ranging from process control to laboratory experimentation. That's why Analog Devices engineers have designed the RTI-1200 real-time analog input/output subsystem for the SBC-80/10. The RTI-1200, which plugs directly into the microcomputer's card cage, is the first in a family of such analog interface units for microcomputers.

The data-acquisition section includes a complementary-MOS multiplexer, a programable-gain amplifier, a sample-and-hold amplifier, and a 12-bit analog-to-digital converter. The basic version provides either 16 single-ended or 8 differential analog inputs, and an on-board expander option is available to double the number of input channels. Two optional general-purpose logic drivers in the output section can also be accessed through software to convert 12-bit digital data into analog command signals to actuate recorders or servos, for example.

The subsystem, by means of its memory-mapped I/O feature, appears to the microcomputer as a set of memory locations. James D. Fishbeck, marketing manager, says this is important because it allows use of all the microinstructions in the 80/10's memory with the RTI-1200. It also permits all data and command signals going into the 1200 to be done with write commands, and all data output can be accomplished with read instructions. For example, a 12-bit a-d conversion command can't normally be implemented with one 8-bit-byte instruction, but the 8080 comes with an instruction that allows two bytes to be read with a single instruction, and the RTI-1200 takes full advantage of this to speed throughput, according to the company.

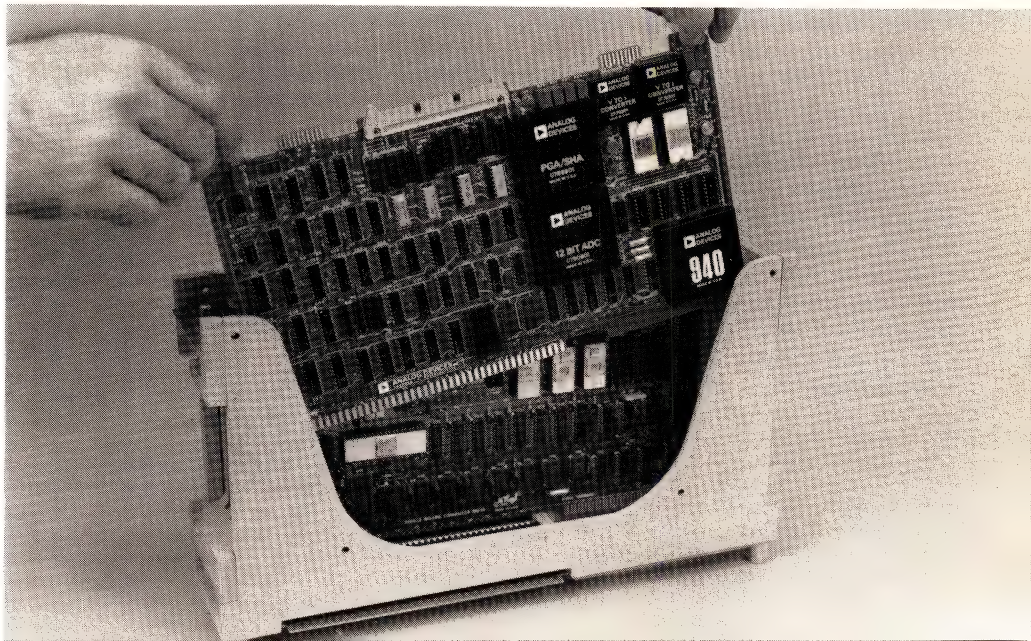
In addition to the two general-purpose logic drivers, other features that Fishbeck says are novel in the RTI-1200 are its real-time clock system, a 5-volt reference signal brought out from the board for testing or calibration, a dc-to-dc power converter, and a built-in socket for a programable read-only memory that either expands the microcomputer's program storage or can accommodate subroutines unique to the RTI-1300 if the user wants more than one analog-interface subsystem to work with the microcomputer.

The real-time clock system provides for two clocks that can precisely trigger action at a predetermined time after some real-time event. For example, the system could signal a computer interrupt to increment the counter and ultimately trigger the opening or closing of a valve in a process-control system.

The dc-to-dc power conversion is an option that derives a ±15-v signal from the microcomputer's basic 5-v supply, allowing the RTI-1200 to be run off the microcomputer's supply. There's also an overvoltage-protection network of diodes and fusible resistors in the analog-input section that allows the unit to tolerate as much as 28 v continuously. If that level is exceeded, the replaceable resistors will blow to protect the board up to about line voltage.

The basic RTI-1200 board sells for $629, depending on options.

Analog Devices Inc., P.O. Box 280, Route 1 Industrial Park, Norwood, Mass. 02062. Phone Lowell Wickersham at (617) 329-4700 [338]



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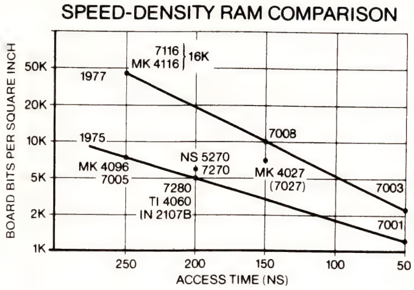

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Semiconductors

Linear-IC voltages zoom

Nine families of regulators, interface circuits to have improved breakdown ratings

It takes larger and larger voltages to destroy linear integrated circuits these days. Over the next few months, Signetics Corp. will introduce as many as nine separate bipolar families of voltage regulators and interface circuits with improved breakdown-voltage ratings.

Being announced now is the 78HV00 family of 1-ampere, three-terminal positive voltage regulators with guaranteed minimum input breakdowns of 60 volts. According to Lew Johnson, general manager of linear/analog products, soon to follow will be 60-v breakdown versions of the industry-standard 7900 series of negative voltage regulators as well as the 78MG series of adjustable regulators.

Also in the works, he says, are the UDN 5711/12/13/14 series of dual peripheral drivers with guaranteed minimum breakdowns of 80 v as well as a 90-v-breakdown version of the NE541 power driver and 100-v models of the NE584/585 gas-discharge-display segment and digit drivers.

To achieve high-voltage performance, says Johnson, Signetics uses a special linear bipolar process that employs a thick sloped oxide on each transistor structure, eliminating the traditional "stair-step" profile usually associated with linear bipolar devices. By varying the slope of the transistor profile, he says, breakdown voltages can be varied, depending on the particular constraints of each device family, from a guaranteed minimum of 60 v up to about 110 to 125 v. Work is also under way, he says, to boost the minimum breakdowns to about 150 v by ion-implantation techniques without any other substantial changes in processing.

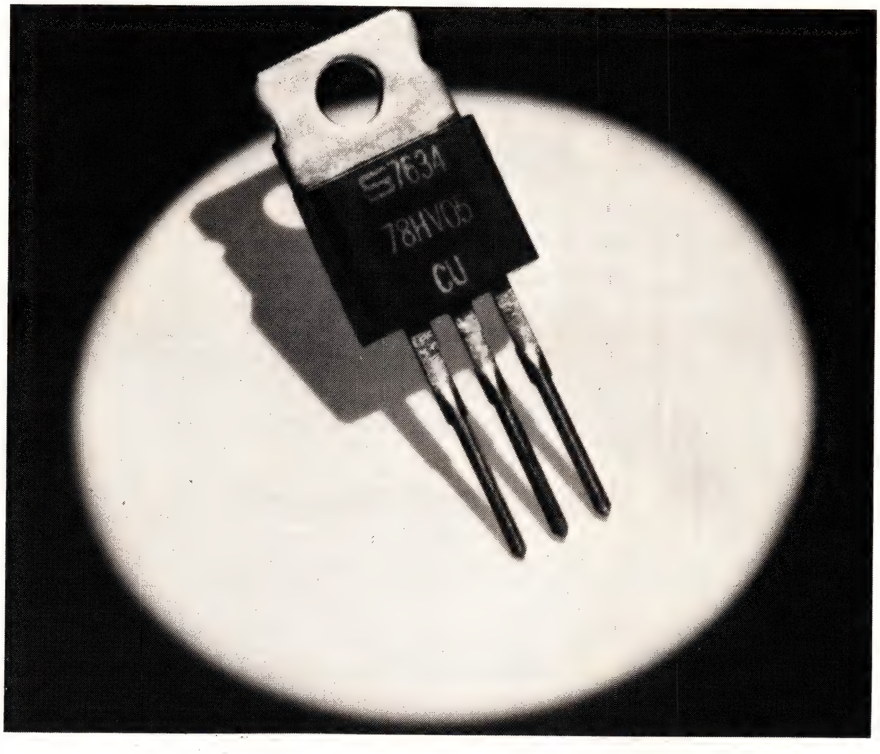
In the 78HV00, 79HV00 and 79MG voltage-regulator families, says Jim Wyland, industrial products marketing manager, the combination of 60-to-100-v breakdowns with thermal shutdown and output transistor safe-area compensation provides "virtual indestructibility in standard circuit applications." The higher ratings, he says, improve a system's reliability, permitting it to handle large transients and ac line fluctuations without damage. With adequate heat-sinking, output current is typically in excess of the specified 1-ampere rating. Unlike present devices, no external components are required, he says, in standard regulator applications. Units in the 78HV00 line are available with output voltage ratings of 5, 6, 12, 15, 18 and 24 v in either TO-220 or TO-3 packages.

The UDN5711 series of dual peripheral drivers is designed for applications where breakdown voltage must be higher than that provided by the industry-standard 75451 series. The pinout is similar to that of the 75451 through 75454 devices. The new series features 80-v breakdown in the off state as well as high current, about 300 milliamperes per driver, in the on state.

The NE541 is a monolithic class AB power amplifier designed specifically to drive a pair of complementary output transistors. Supply voltage is ±42 v, current gain 70 to 90 decibels. Gain variation over temperature with 40-dB gain is ±0.1 dB. Frequency response at 40-dB gain, ±1 dB, is 100 kilohertz.

Typical price on the high-voltage regulators is $1.56 in quantities of 100 to 999 for the 78HVO5CU (rated for 5 v and housed in a TO-220 package) and $2.26 for a 178HV24CDA (rated for 24 v in a TO-3 package).

Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086 [411]



Schottky barrier diodes sell for 45 cents

The low forward-voltage drop of a Schottky barrier diode makes the device an excellent replacement for a germanium pn junction diode in many general-purpose switching applications, provided that its cost is

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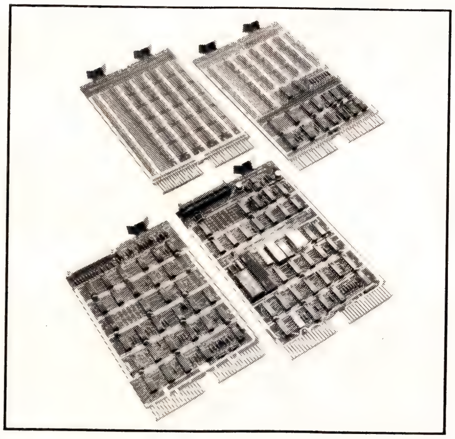
Here are some MDB Systems connections to LSI-11 microprocessors:



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  - Card equipment
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  - Plotters
- ☐ Communications/Terminal Modules
  - Asynchronous Serial Line Interface
  - Synchronous Serial Line Interface
- ☐ MDB Backplane/Card Guide Assembly
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  - System monitoring unit provides front panel
  - Switch addressing
  - Power on/off sequencing
  - Bus extenders/terminators
  - E-PROM and PROM modules
  - Bus connectors for backplane assemblies

Check first with MDB Systems for your LSI-11 interface requirements.

MDB also supplies interface modules for DEC PCP-11, Data General NOVA, and Interdata minicomputers.

Circle 204 on reader service card

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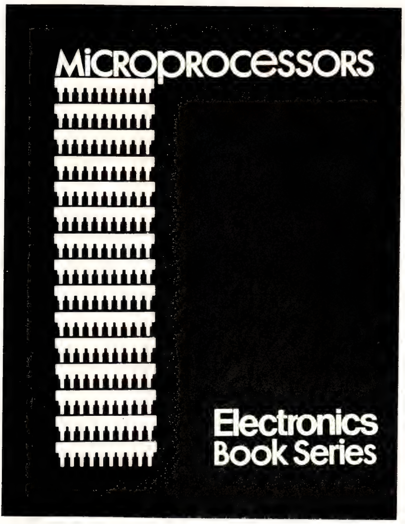
What you must know about Microprocessors

This book cuts through the confusion, presenting the design and application potential of this exciting technology in a manner that will appeal to the design engineer who needs to know how to use microprocessors as well as the system analyst who must assess the tradeoffs between microprocessors and other techniques to accomplish his system goals.



Using articles from the pages of Electronics, the book contains practical and up to date information on available microprocessor devices, technology and applications—ranging from the simplest 4-bit p-channel MOS system to the second-generation n-MOS 8-bit processor chips, and the new injection logic and Schottky TTL bipolar processor families needed for the toughest computer-based control applications.

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the single-chip that beats them all.

This.

Not this.

	Motorola MC14433	Siliconix LD130	Siliconix LD110/111	Integrated Photomatrix MC904
No. Chips	1	1	2	1
No. Digits	3½	3	3½	3½
On Chip OSC	Yes	Yes	No	No
Low Voltage Range 200 mV (100 µV res.)	Yes	No	Yes	Yes
Power Supplies	2	2	3	2
External Passive Parts	4	3 + 1 JFET	7	10
No. References	1	1	1	2
Power mW	8	25	220	300
No. Pins	24	18	16/16	28
Control Signals	2	0	1	1

Two-chip A/D converter approaches were the beginning, but they were a bit primitive. Early single-chip A/D converters were a step in the right direction, as far as they went. Now it's time for something better. It's time for Motorola's full 3½ digit all-CMOS, single-chip A/D converter.

Who doesn't prefer 3½ digits to three in just about any low cost digital meter or A/D measuring system. For some, the additional low voltage range of the MC14433 is the big advantage. For others, it's the miserly power consumption of this LSI unit which combines Motorola's state-of-the-art CMOS linear and reliable CMOS digital on the same chip.

Get it all for under $10.00

That combination of features in one device would have made the MC14433 a bargain at a much higher price. Happily, initial yield and output are so good we're introducing the MC14433P at $9.97 in 100-999 quantities. And, look at the added savings you get from the requirement for just four inexpensive external passive components to make it work as a converter. You save on board layout and manufacturing, too.

Of course the MC14433 has all the other features you'd expect and want: auto polarity, auto zero, single positive voltage reference, low cost power supply requirements, up to 25 conversions per second, overrange and underrange signals, versatile operation with LED, LCD, and gas discharge displays, and accuracy of ±0.05% ±1 count.

Not the least of the MC14433's advantages is confidence. It rolls off the same lines as our high volume digital CMOS, so you know it's going to be available when you need it. The special MC14433 data sheet has seven pages of applications information in addition to the usual data. Your copy is waiting. Just circle the reader service number or write to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036.

Order all the MC14433s you want right away. We've got plenty. Contact your favorite authorized Motorola distributor or your Motorola sales office.

Semiconductors
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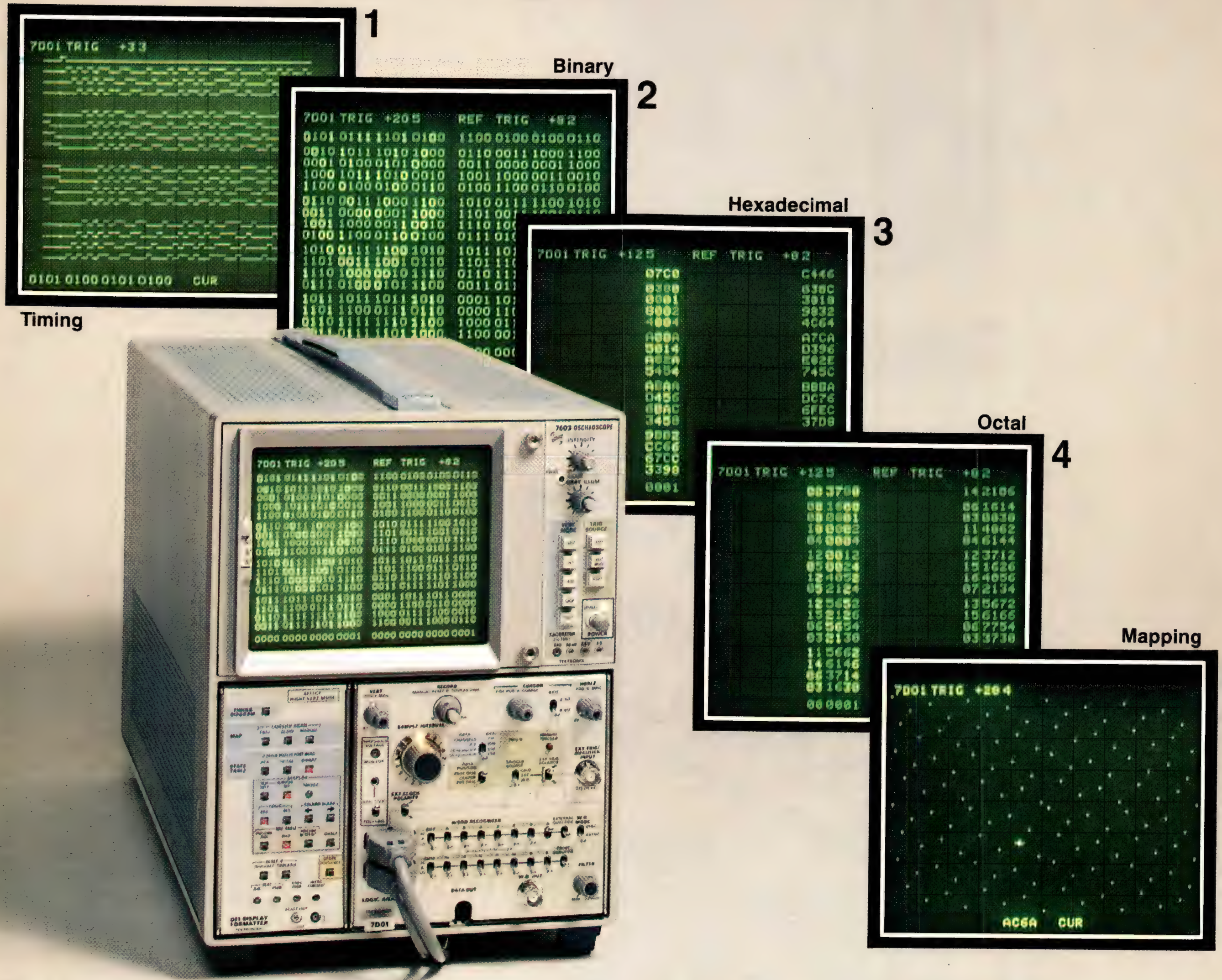
TEKTRONIX now has 5 ways to look at logic.



The New DF1 Formatter

First, we gave you the timing display and binary readout with our 7D01 Logic Analyzer. *Now,* with the DF1 Display Formatter, which is dedicated to the 7D01, you have five display formats to operate from, all in a 7000-Series mainframe. Now you can convert a timing display into tables of words in Binary, Hexadecimal, Octal ... or a mapping configuration ... whatever your application requires.

A STATE TABLE mode of operation produces standard tables of up to 16 lines of 16-bit words. Using the 7D01's cursor, you can step through these tables word-by-word in Binary, Hex, or Octal. A 17th word is added to each table emerging from the 7D01's memory, to serve as a "key" and indicate you are indeed scrolling correctly through the long memory. The 7D01's fine cursor control steps the display line-by-line, while the coarse control advances it table-by-table.

One of the most powerful analytical capabilities provided by the STATE TABLE mode is that you can display *two* tables–a reference table of "proved" data plus a "new" data table drawn from a system under test–on the same crt for side-by-side comparison. New data that is different from the reference data is automatically intensified ... you immediately know faulty data exists, and you know its location.

With the DF1 you can map, not just one, but three ways. The ability to map FAST, SLOW, or MANUAL lets you quickly recognize a word of interest, track it, isolate it, then pinpoint it for detailed analysis. The importance of mapping is derived from the speed with which you can isolate problems.

The logic analyzer package shown (7603 Option 1, 7D01, DF1) starts as low as $5790. If you already own a 7000-Series mainframe, add the 7D01-1 (7D01/DF1 combination) for only $4390. Also consider that your money buys you these important 7D01 features: 1) Word recognition, 2) 16 channel operation, 3) 15-ns asynchronous timing resolution, 4) 4k formattable memory (4, 8 or 16 channels), and 5) High Z probes.

For more information or a demonstration of the DF1, contact a Tektronix Field Engineer near you. Or write Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077.

United States sales prices are F.O.B. Beaverton, OR. For price and availability outside the United States, please contact the nearest Tektronix Field Office, Distributor, or Representative.

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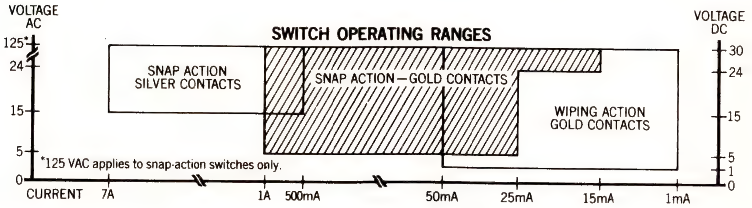
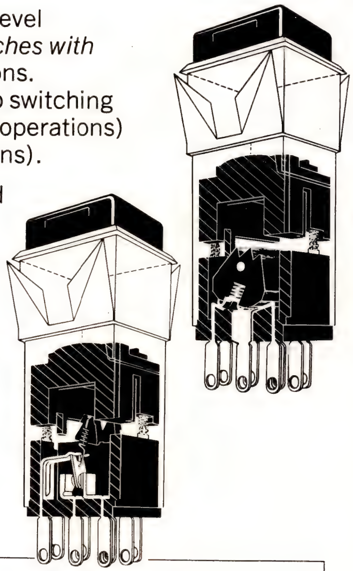
Dialight Switches

A switch for all reasons.



Reason 1: Dialight offers three switch configurations to meet all your needs—*snap-action switches with silver contacts* for moderate-level applications, *snap-action switches with gold contacts* for intermediate-level applications, and *wiping-action switches with gold contacts* for low-level applications.
Each of these ranges is served by two switching actions—momentary (life: 750,000 operations) and alternate (life: 250,000 operations).



Reason 2: Dialight's snap-action and wiping-action switches come in a new modular design concept . . . a common switch body for either high or low current operation. All 554 series switches and matching indicators have the same rear-panel projection dimensions.

The snap-action switching mechanism guarantees a fast closing and opening rate.
This insures that contact force and contact resistance are independent of the switch's actuation speed.

In the wiping-action switch, the contacts are under constant pressure (A unique Dialight design). This insures long life with a minimum build-up of contact resistance.

Both switch types are tease-proof.

PRODUCT SELECTOR GUIDE

SWITCHING ACTIONS	Snap-Silver contacts		Snap-Gold contacts		Wiping-Gold contacts	
	SPDT	DPDT	SPDT	DPDT	SPDT	DPDT
MOMENTARY	○	○	○	○	○	○
ALTERNATE	○	○	○	○	○	○

OPTIONS

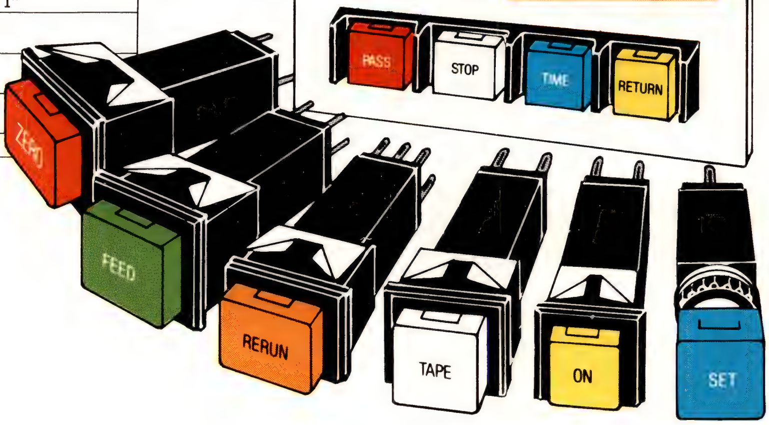
	PUSH BUTTON CAP SIZES				
	½″ Sq.	⅝″ Sq.	⅝″ x ¾″	¾″ Sq.	¾″ x 1″
BEZEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
BEZEL MOUNTING WITH BARRIERS TO ACCOMMODATE		○	○	○	○
PANEL MOUNTING TO ACCOMMODATE	○	○	○	○	○
MATCHING INDICATORS	○	○	○	○	○

Reason 3: Dialight offers a wide variety of panel and snap-in bezel mounting switches with momentary and alternate action configurations in SPDT and DPDT types. There are over 240 switch variations to choose from.

The 554 illuminated switch, designed for front of panel lamp replacement, gives you a choice of five different bezel sizes . . . ¾″ x 1″, ⅝″ x ¾″, ¾″ square, ⅝″ square, and ½″ square. The first four sizes are also available with barriers. You also get a choice of six cap colors . . . white, blue, amber, red, green, and light yellow . . . four different underlying filter colors . . . red, green, amber, and blue and a variety of engraved or hot-stamped legends . . . over 300 cap styles . . . over 100,000 combinations.

There is also a variety of terminal connections . . . solder blade, quick connect, and for PC board insertions.

Reason 4: Dialight's 554 series is designed as a *low cost* switch with *computer-grade quality.*



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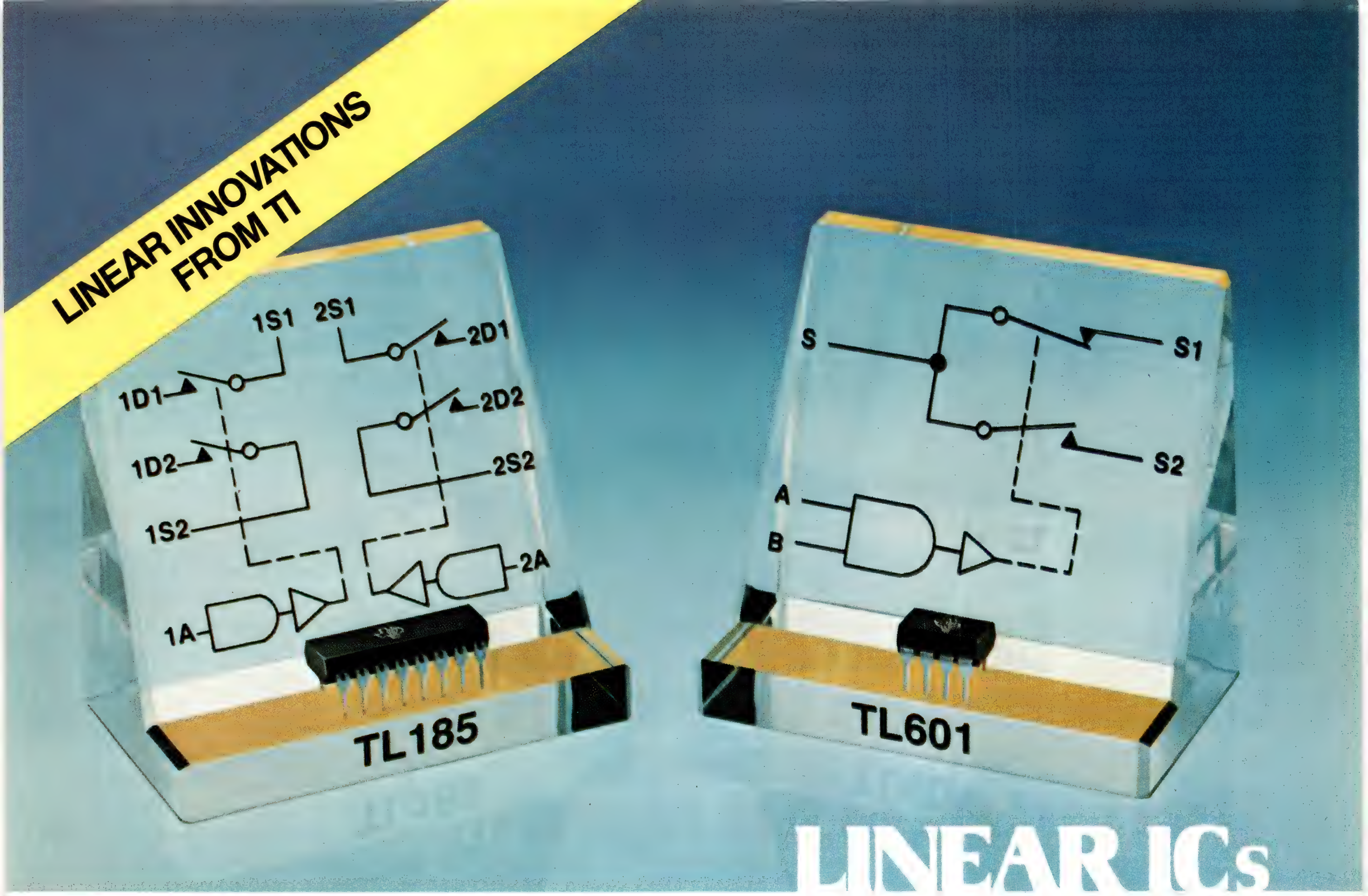

Now, analog switches go monolithic. Priced for commercial applications.

Expensive hybrid analog switches are out. TI's pioneering use of BIMOS, BIFET, and ion implantation technologies introduces a major innovation: single-chip, monolithic analog switches. At less than $1.00 per switch.

You also get fast speeds. High reliability. TTL compatible inputs. Easy triggering. Low leakage. No latch-up.

TI's new TL600 Series is a general-purpose family featuring high r_{off}/r_{on} ratio and no offset voltage. Ideal for signal switching, multiplexing, and controlling op amp gain. $0.88 in 1K quantities.

TI's new TL181 Series provides symetrical on-state resistance to allow switching of precision AC signals without distortion. JFET control input allows series to be driven by TTL, ECL, CMOS, or PMOS circuits. The series is functionally interchangeable with the Siliconix DG181 Series having the same pinouts. Just $1.88 each in 1K quantities.

For more details about these new TI analog switches priced for widespread use, return the coupon.

TI Analog Switches

AVAILABLE NOW

Series	Channel	Type	Typical On-State Resistance (Ohms)
TL601	1	SPDT	75
TL604	1	Dual SPST (Complement)	75
TL607	1	SPDT (with inhibit)	75
TL610	1	SPST	40
TL182	2	SPST	50
TL185	2	DPST	75
TL188	1	Dual SPST (Complement)	50
TL191	2	Dual SPST (Complement)	75

Texas Instruments
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EL-11

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☐ TL600 Series
☐ TL181 Series
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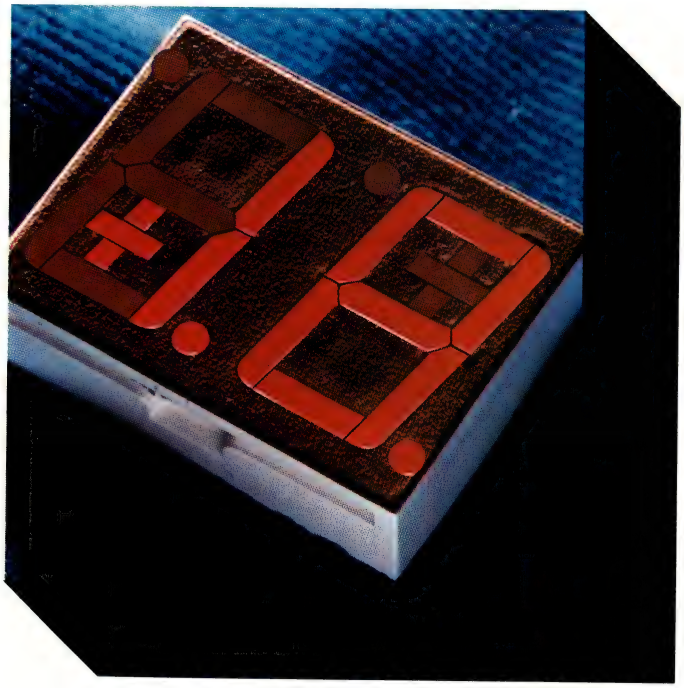
Big 0.6″ double and single digits.

Our new super bright orange double- and single-digit displays are available in both common cathode and common anode configurations. These 0.6″ digits (with overflow) incorporate our latest rounded-corner solid segment font to give you a display that's easy to read and easy to like.

The package is new, too. It has a colored face for optimum ON/OFF contrast. It's just under an inch in length and packs densely to provide digits on .50″ centers.

The light emitting material is our new GaAsP:N on GaP, so you get all the benefits of this new high brightness technology—including direct MOS drive—plus all the inherent shock resistance and long life of solid state. Not bad.



Model Number	Description	Color	Luminous Intensity*
MAN 6610	2 Digit; Common Anode, RHDP	Orange	510 μcd
MAN 6630	1½ Digit; Common Anode, Overflow (±1.8), RHDP	Orange	510 μcd
MAN 6640	2 Digit; Common Cathode, RHDP	Orange	510 μcd
MAN 6650	1½ Digit; Common Cathode, Overflow (±1.8), RHDP	Orange	510 μcd
MAN 6660	Single Digit; Common Anode, RHDP	Orange	510 μcd
MAN 6680	Single Digit; Common Cathode, RHDP	Orange	510 μcd
MAN 6710	2 Digit; Common Anode, RHDP	Red	125 μcd
MAN 6730	1½ Digit; Common Anode, Overflow (±1.8), RHDP	Red	125 μcd
MAN 6740	2 Digit; Common Cathode, RHDP	Red	125 μcd
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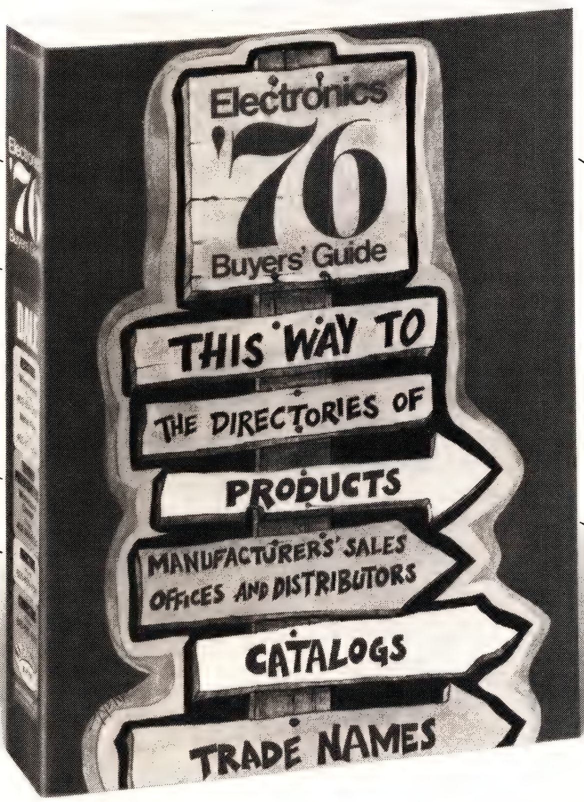

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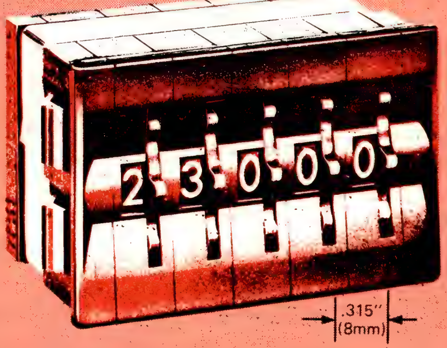

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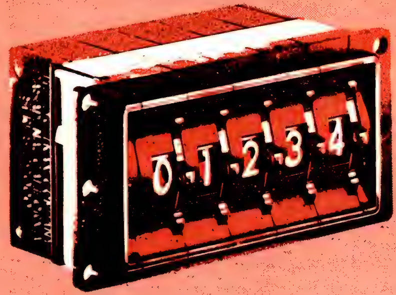

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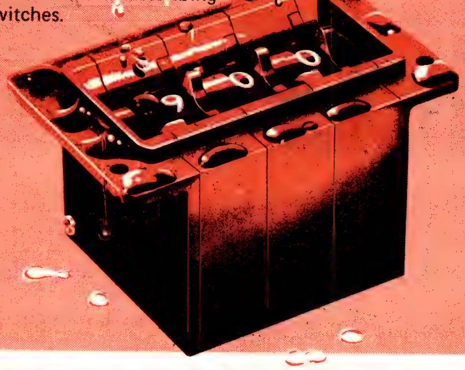

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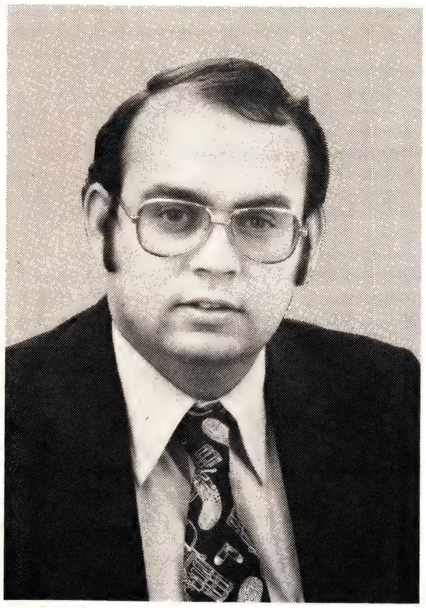
Is Modular Sensorialization the Answer to Efficient Microprocessor Testing?

by Richard C. McCaskill, Manager, Applications Services



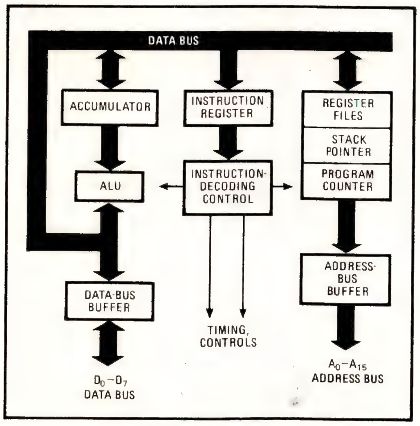
With the development of LSI technology have come testing problems every bit as complex as the new circuits themselves. Consequently, a serious question has arisen. Do we continue with traditional "gate" test methods such as "path sensitization" or look to newer perhaps more well suited methods?

New Methods

Modular sensorialization, one of these new methods, is designed to test a module or a subsystem – instead of concentrating on each of the hundreds of MPU gates. And since a single chip MPU consists of relatively few modules, the procedure is relatively simple. Here is a brief description of that method.

Circuit Architecture

The first step in modular sensorialization is the investigation of the architecture of the MPU and the consequent partitioning of the MPU into modules. Each module should be accessible on the I/O bus by executing a proper set of microprocessor instructions in order to propogate its results directly or indirectly to the I/O bus for sensing externally by executing a defined set of instruction sequences in the microprocessors own language. When dealing with each particular module, every effort should be made to run a worst-case test pattern, subject to the instruction executability. Once the first module is fully tested, then the procedure applies to each module until all modules within the MPU are covered. As a result of this, the entire MPU will be fully tested from the hardware viewpoint.



On the bus. Microprocessors may be viewed as assemblies of independent functional blocks that can be tested separately. Address and data buses tie the blocks together and provide access to each.

Software Architecture

Software is tested in a similar manner. A set of MPU instructions should be executed when testing the first module. Then, on the second module, another set of new MPU instructions (the same instruction could be executed previously) can be executed. This same procedure applies to all modules and hence all sets of instructions until all specific MPU instructions are executed one or more times.

This approach provides two-fold diagnostic information. First, from a hardware viewpoint, any faulty module on the MPU will be isolated. Due to the fact that this approach is a modularity procedure, a break point is inherent in the test flow of each module to facilitate the modular diagnosis. Secondly, in conjunction with each module, a set of MPU instructions will be executed and thus any malfunction on a specific instruction or a specific set of instructions can be identified.

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Because of the ever increasing pace of technology, Macrodata recognizes there can be no one answer to every testing problem. That's why we are continuing to update and broaden the capability of our LSI test systems and our library of test programs and software to stay abreast of industry needs.

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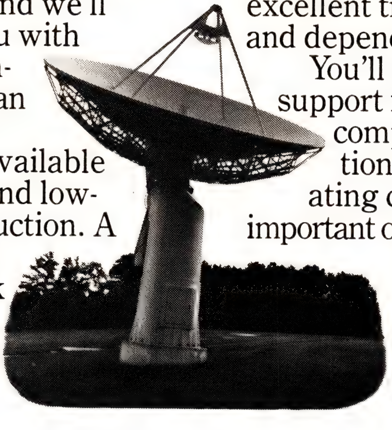

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Data handling

Computer kit sells for $995

'Personal' machine, built around 8080 microprocessor, includes RAM and ROM

The cost of personal computers continues to come down. A complete computer kit, built around the Intel 8080 microprocessor, is being offered for $995 by Processor Technology Inc., Emeryville, Calif., which claims this is the lowest-priced complete computer on the market. It comes with a walnut-sided cabinet and includes 1,024 words of static low-power random-access memory, 1,024 words of preprogramed read-only memory, a 1,024-character video-display circuit, and an 85-key solid-state keyboard. It also has an audio-cassette interface that can control two tape recorders at 1,200 bauds, as well as parallel and serial standardized interface connectors, a power supply and a fan.

The unit runs the company's version of Basic—Basic-5, which is included in the package as a tape cassette, plus a new version called PT 8K Basic, for $29, also in cassette form. This requires 8 kilobytes of memory. Other software includes two resident assemblers, a new compiler for Focal, the high-level language developed for the Digital Equipment Corp. PDP-8, a set of video games, and a video calculator called Mathpack.

The unit's memory is expandable to 65,536 kilobytes. The latest memory-expansion module from the company is one with 16 kilobytes of RAM, selling for $529 in assembled form. The computer cabinet has five expansion slots, for such modules as memory, and an interface expansion board with two 8-bit parallel input/output ports with full handshaking logic and a serial data rate that can be set between 35 and 9,600 bauds.

The company also has a set of peripherals that include line and serial printers, perforated tape readers, floppy-disk memories, black-and-white and color displays, and analog-to-digital and digital-to-analog converters. With the displays, which are modified television monitors, the unit will show 16 lines of 64 characters each, including 86 ASCII upper- and lower-case characters, plus 32 selectable characters. The display position is continuously adjustable in both the horizontal and vertical directions.

The unit works with all S-100 bus types, including those of Altair and Imsai. The basic one-board computer is available alone in kit form for $475.

Processor Technology Inc., 6200 Hollis St., Emeryville, Calif. 94608 [361]

Tape formatter is compatible with IEEE interface bus

What its manufacturer says is the first buffered magnetic-tape formatter that is compatible with the IEEE 488-1975 interface bus allows users to add any industry-standard tape drive to a bus-oriented system. The model 1015A provides asynchronous data transfer both to and from synchronous tape recorders such as those made by Cipher, Pertec, Wangco, and Kennedy.

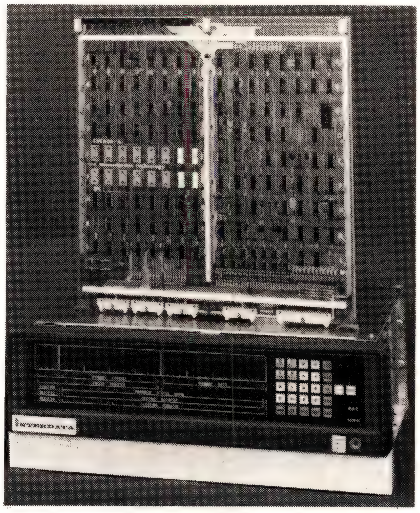
Available in seven- and nine-track versions with a choice of several packing densities, the formatter provides read-after-write error checking with automatic correction. It uses a Z-80 microprocessor both to control the bus interface and to perform the memory-management function.

Dylon Corp., 7854 Ronson Rd., San Diego, Calif. 92111. Phone (714) 292-5584 [363]

One-card disk controller sells for $1,900

A single-board disk controller that can interface an Interdata minicomputer with up to four CalComp Trident disk drives sells for only $1,900 in unit quanities. Designated the TDC803, the controller occupies only one slot in the chassis of any current Interdata computer. It reduces the price of a 50-megabyte disk system to less than $8,000.

The controller provides sector buf-



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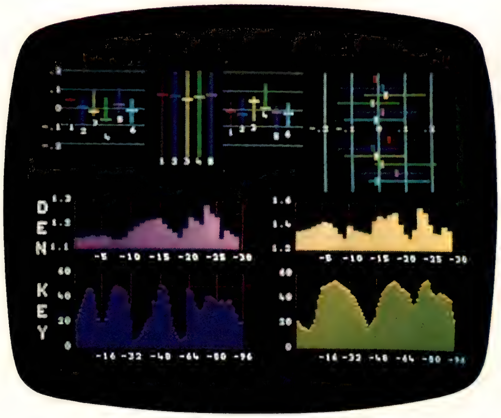
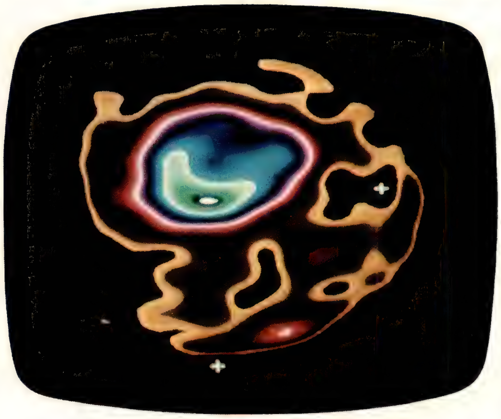
Ramtek's new RM9000 modular graphics and imagery system gives you expandability, economy and flexibility.



Process Control: Color printing press.



Medical Imaging: Nuclear heart study.

Select The Performance You Need.

The RM9000's total modularity lets you select the exact performance you need to fill your particular application. You pay only for the performance you need. Nothing more. And that's like money in the bank.

Add On As You Have To.

As your needs change and grow, the RM9000's capability will grow right along with them. A comprehensive list of options such as expansion from black and white to grey scale or color—even a complete range of interactive peripherals and additional independent channels.

Microprocessor-Controlled Raster Scan.

The RM9000 is the first raster scan graphics and imagery system to be totally microprocessor controlled. That means you can implement a higher-order user language to minimize programming costs without a sacrifice in system throughput.

Functional. Reliable. Maintainable.

High reliability is the direct result of intensive testing of components and systems prior to shipment. Solid state components and printed circuit construction are used exclusively. Result? No special preventive maintenance measures are required. In fact, the RM9000 can be pre-programmed with self-diagnostic capability.

You Need To Know More.

To fully appreciate the RM9000's capability, you need more details. Call or write Ramtek Corporation, 585 N. Mary Ave., Sunnyvale, CA 94086. (408) 735-8400.

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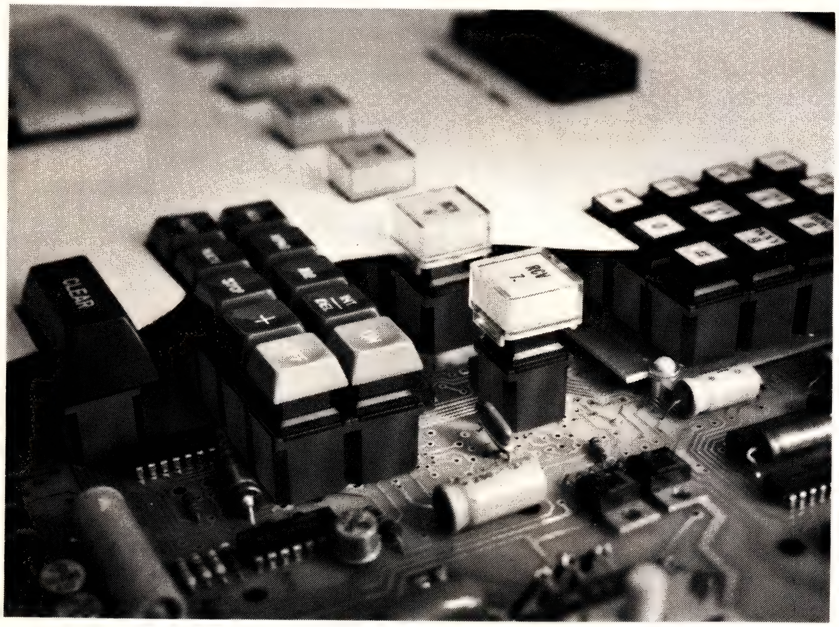
Our Experience Shows

KEYBOARD SWITCHES for INSTRUMENT PANELS



Now is the time to stop hand wiring to *expensive* panel-mounted switches.

Mechanical Enterprises' keyswitches are available at about *half-the-cost*. And, they are *self-supporting* on the PC board without the need for metal sub-plates.

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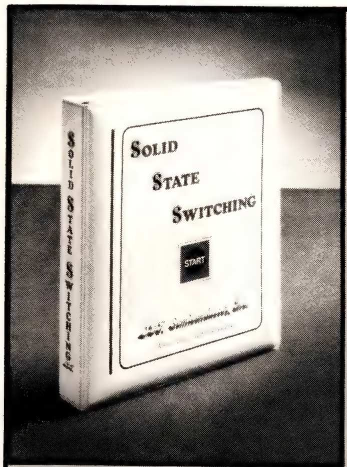

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Our DEMO-BOARD incorporates 4 different applications. We show you how to design and produce low-cost keyboards. Test the switches. Make measurements through provided points. Available in English, German, French, Japanese and Spanish. For a FREE COLOR BROCHURE, write or call us today.

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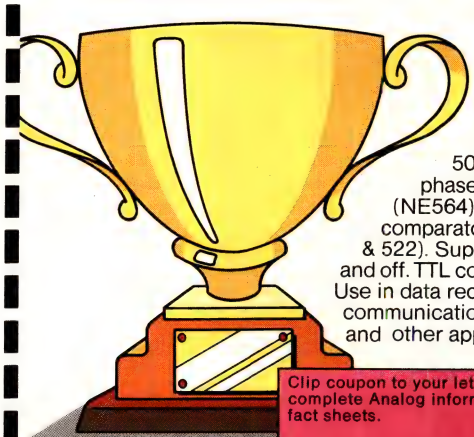

The first 50 MHz digital phase locked loop (NE564) and dual comparators (NE521 & 522). Super fast on and off. TTL compatible. Use in data recording communications and other applications.

Clip coupon to your letterhead for complete Analog information and fact sheets.

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Bidirectional printer hammers out 200 lines/min

The model T-1602 matrix printer uses optimized bidirectional printing to achieve throughput speeds in excess of 200 lines per minute. The 160-character-per-second unit contains a microprocessor, which computes the shortest distance to each successive print position.

Standard features include a 7-by-7 matrix font, double-width character capability, upper- and lowercase printing, forms-length selection, and self-test. Capable of handling form widths from 4 inches to 15 in., the T-1602 prints an original plus four carbons. OEM prices start at $3,115; delivery time is 60 to 90 days.

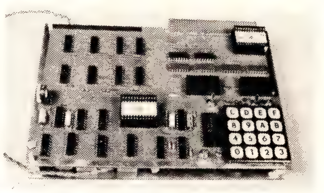
Tally Corp., 8301 S. 180th St., Kent, Wash. 98031. Phone John Roberts at (206) 251-5644 [368]

Circuit board couples digitizer with PDP-11

An interface in the form of a single quad-width circuit board connects the Summagraphics Corp. data-tablet/digitizer with DEC's PDP-11 minicomputers. The interface transfers X-Y coordinate information to the computer and operates in either programed input/output or interrupt mode. Price of the interface with a 10-foot connecting cable is $1,350.

Summagraphics Corp., 35 Brentwood Ave., Fairfield, Conn. 06430 [369]

1702A MANUAL EPROM PROGRAMMER



Features hex keypad, two digit hex address and two digit hex data display. Controls include load, clear, go! (step), key/copy, data in/data out, and counter up/down. Profile card includes high voltage pulse regulator, timing, 8 bit address and 8 bit data drivers/receivers. Two 6½" x 9" stacked cards with spacers. Allows programming in 20 minutes – copying in 5 minutes. Requires +5, –9, and +80 volts.

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KIT $189.95

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IMSAI/ALTAIR computer interface (requires 3 output ports, +1 input port) and software $49.95

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Our NEW 16K Byte Pseudo-Static, IMSAI/ALTAIR compatible RAM. Single card slot. Uses less power than equivalent low power RAM. All memory chips socketed. Uses all prime, factory fresh ICs. High quality, two-sided, through-hole-plated circuit board. Crystal controlled, totally invisible refresh system requires NO software management. Just plug it in and use like STATIC memory.

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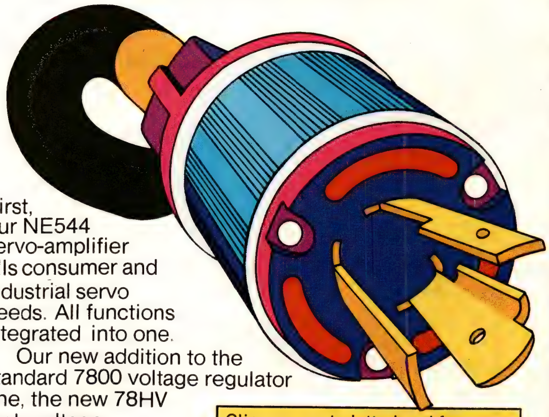

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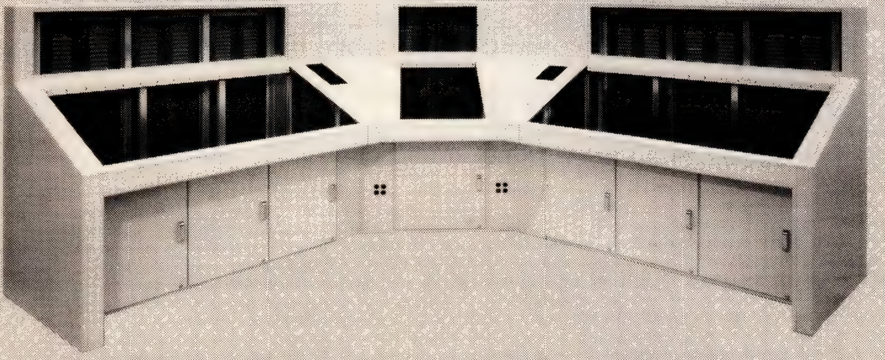

This is a special enclosure Bud helped design, then we built and delivered it on time. Special fabrication is a big part of our business; we know what we're doing – and we do it one of three ways: Adapting a standard product that'll fit a system; creating an entirely new enclosure; using the Imlok system, one that's ideal for short runs or prototypes. **YOUR PROBLEM IS SOLVED!**

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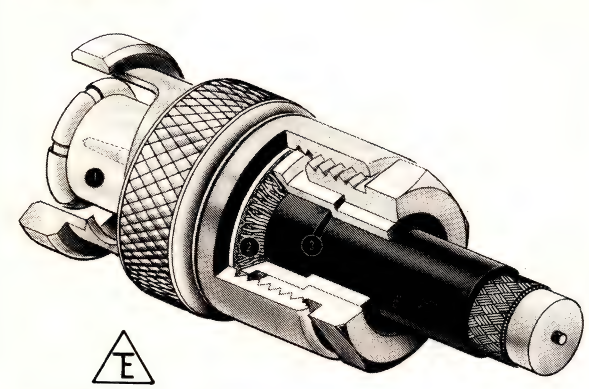

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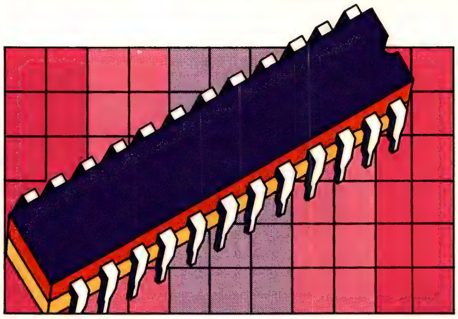

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of 500 or more is $63. Delivery time is 30 days after receipt of order.

Isotek Corp., 567 Chickering Rd., North Andover, Mass. 01845. Phone Donald Drew at (617) 685-1511 [381]

Standard clock module is developed for autos

By working with each auto maker on an almost custom basis—designing a particular system to a specific model line—semiconductor manufacturers have hoped to gain an inside track on possible future business, even though it leaves their options in the existing automobile market somewhat limited. National Semiconductor Corp. has decided to do things differently.

In an unorthodox move, it is going after both markets, introducing as a standard product a 12-volt automotive instrument clock module that is designed to meet or exceed most of the criteria demanded for automobile use.

According to Jerry Zis, module products marketing manager at National, the MA1003 is based on the MM5377 monolithic p-channel large-scale-integrated clock circuit. To this is added a 2,097-megahertz crystal, supporting buffer components, and a four-digit 0.3-inch-high green fluorescent display, to form a complete digital clock for 12-v dc applications.

The module, says Zis, is fully protected against battery reversal conditions and automotive transients (+40 v for 50 milliseconds, +80 v for 5 ms, and −200 v for 1 ms). Timekeeping is maintained down to 5 v dc.

Brightness is controlled automatically. The chip logic blanks the display when the ignition is off, halves brightness when park or head lamps are on, and follows the dimmer-control setting for the dashboard lamp. The bright green display is filterable to various shades of green, blue-green, blue, and yellow.

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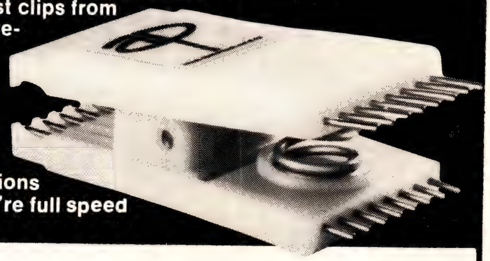

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TC-18	.3 in.	923703	$10.00
TC-20	.3 in.	923704	$11.55
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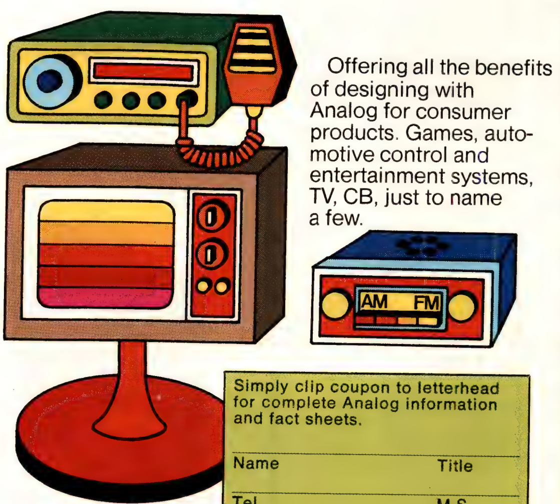

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switches are disabled when the display is blanked. Interconnection to the automobile system is simplified through the use of a six-pin connector on the pc-board module, which measures 3 by 2 inches.

The clock modules cost $40 each for 1 through 99; $25 each in 100-up quantities.

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051 [382]

F-v converter sells for $39

Two modular frequency-to-voltage converters with low-quantity prices as low as $39 offer an output current of 20 milliamperes and a maximum nonlinearity as low as 80 ppm. The 10-kilohertz model 451 and the 100-kHz model 453 provide the versatility of programable input threshold, gain, and output offset voltage. Three versions of each converter are offered; they differ only in nonlinearity and gain-drift performance characteristics.

The 451J and 453J have a 0.03% maximum nonlinearity, 100 ppm/°C gain drift, and respective prices of $39 and $41. For the K versions, the figures are 0.015% nonlinearity, 50 ppm/°C gain drift, and $45 and $47 for the 10-kHz and 100-kHz converters, respectively. The top-of-the-line L versions have the same drift specification as the K units, but the maximum nonlinearity is reduced to 80 ppm, and the prices are raised to $51 and $55. All the units are housed in modules that measure 1.5 by 1.5 by 0.4 inches.

Analog Devices Inc., P.O. Box 280, Norwood, Mass. 02062. Phone Lowell Wickersham at (617) 329-4700 [384]

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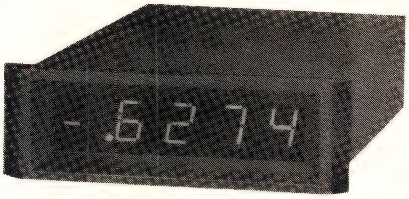

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PM-3.5		±0.05% F.S.	Standard	Standard	Standard	3-1/2	$ 99
PM-4		±0.02% F.S.	Standard	Optional	Optional	4	$170
PM-3.5AC	VAC - 2V, 20V, 200V or 1000V	±0.5% F.S.	N/A	Standard	Standard	3-1/2	$136

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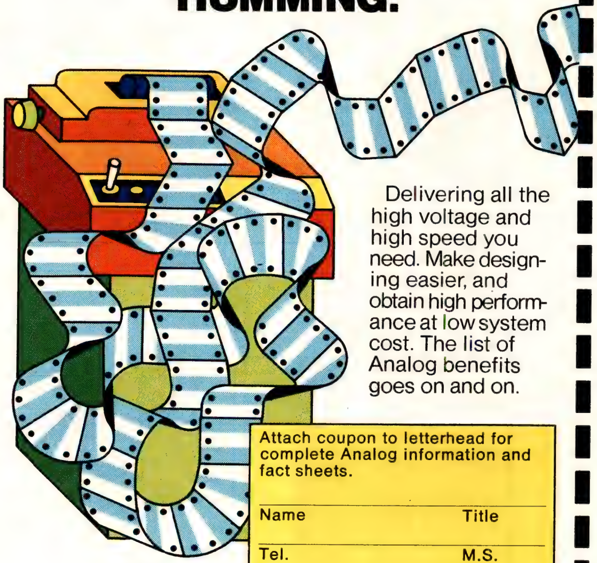

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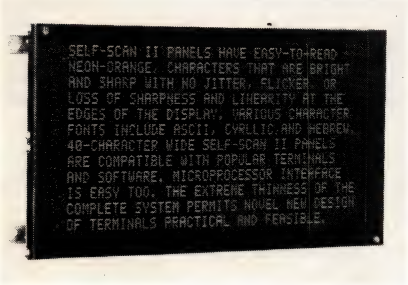
the Quanticircle works over four ranges, and has an autoranging mode of operation. The microprocessor, an RCA 1802D, permits squeezing all the electronics into a standard 4-inch ARINC case.

The display uses a circular array of 100 LED lamps to display analog information and to show secondary echo returns. Trend information is also inherently presented as it would be on any analog display. Principal applications are expected in helicopters, hovercraft, and automatic landing systems. The Quanticircle sells for $5,000 in small quantities.

Osborne-Hoffman Inc., 304 Richmond Ave. (Hwy. 35), Point Pleasant Beach, N.J. 08742. Phone Edwin Hoffman at (201) 899-2770 [386]

480-character display panel is only 1.25 inches thick

Organized as 12 lines of 40 characters each, a 480-character display panel measures a compact 11 inches long by 6 in. wide by only 1.25 in. deep including driver electronics. The driver requires a minimum link to a host system. The gas plasma panel, which has a 100-piece price of $315, is available now in sample quantities at $480. Since the alphanumeric characters are made up of elements of a 5-by-7 dot matrix, the model SII 1240-PD2 display can handle thousands of special characters and symbols in addition to the 64-character ASCII set and foreign-language fonts such as Cyrillic, Hebrew, and Katakana.



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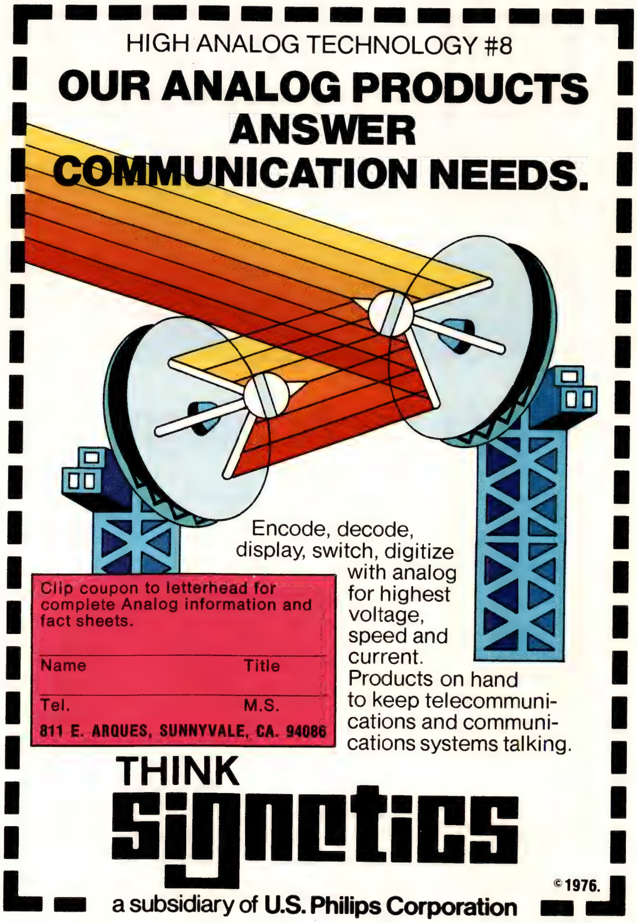

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on analog.

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yes	yes				yes				
		yes	yes			yes			
	yes			yes	yes			yes	
yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

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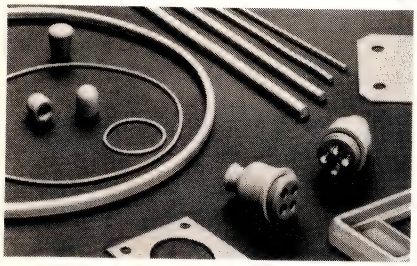

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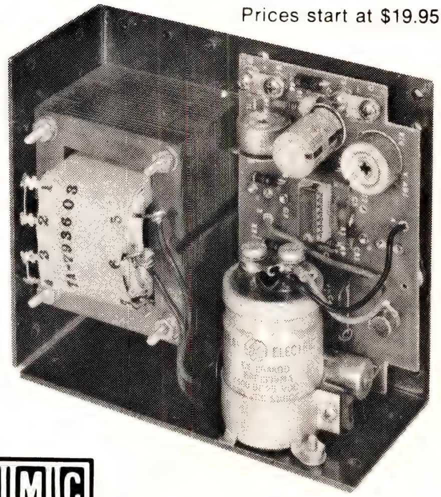

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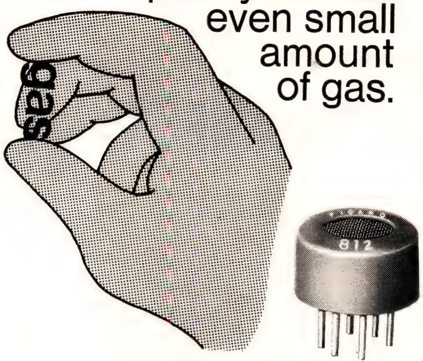

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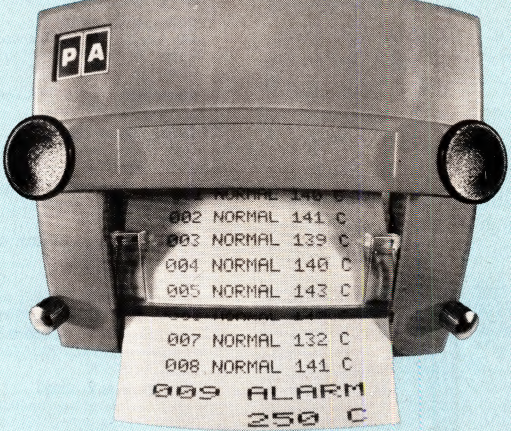

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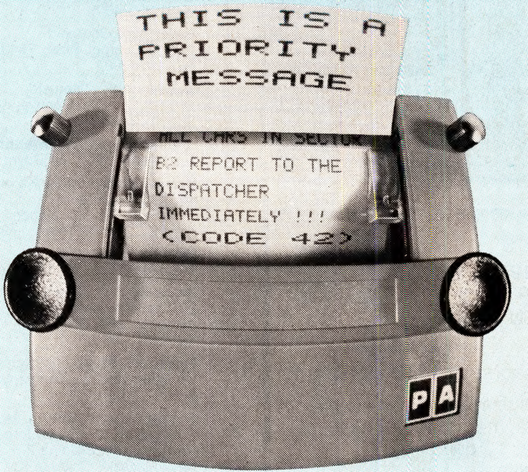
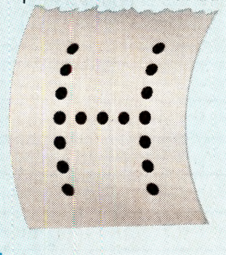


You flipped over our Matri-Dot alphanumeric mini for "first line down" data printing; now we've flipped our design to give you "first line up" text print format, too. So you're ahead, whatever your point of view. Because no one else makes printers as small as 3"H x 3½"W x 7"D. No one else sells them as low as $140 (in quantities of 100). And no one else offers our features. Instead of a drum, our unique print head purrs along at 138 lines per minute for 18 data columns, even faster for fewer columns. Instead of messy ribbons, our exclusive drop-in ink platen lasts for 75,000 lines and replaces from the front panel. And instead of engraved drum limitations, our 7 x 5 dot matrix characters provide full alphanumerics with a complete ASCII 63 character set. Enhanced characters are also available... 8, 10, 12, or 14 characters per inch. All this, plus multiple-copying capabilities and plug-in panel mounting. No matter how you look at Matri-Dot, it's a turn for the better.



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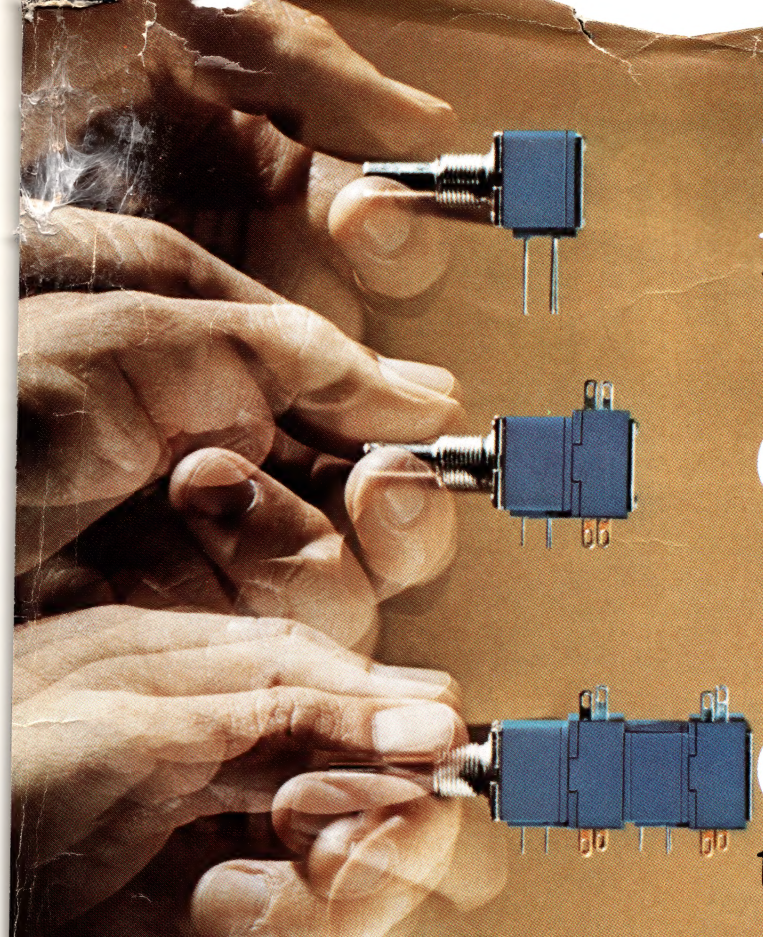

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the pot . . .

CLICK
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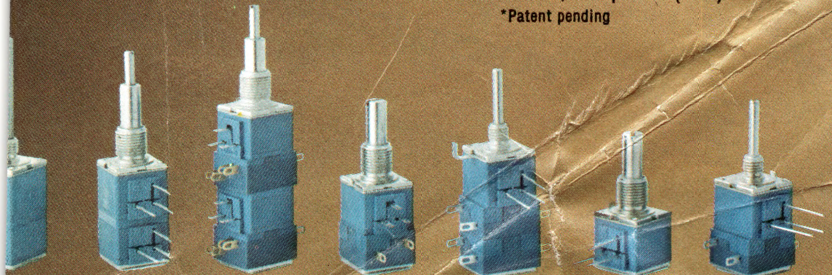
*Patent pending



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